Supplemental Digital Content

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Mapping activity patterns to quantify risk of violent assault in urban environments.

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Table of Contents

eFIGURE 5. Differences, in standard deviation units, between the maximum and minimum level of exposure to features of the environment experienced by subjects during daily activities, as measured by four variables. Each figure is a histogram showing the proportion of subjects who experienced a given absolute difference in exposure to one of the four variables. The number in each figure is the proportion of subjects who experienced a highest level of exposure to a factor that was at least one standard deviation greater than the lowest level of exposure to the variable.

eAPPENDIX 1. Introduction.

eAPPENDIX 2. Methods.

eAPPENDIX 3. Results.

eAPPENDIX 4. Discussion.

eTABLE 1. Questions administered during the baseline survey.

Grades received in school
What type of grades do/did you get? (A's and Bs; B's and C's; C's and D's; D's and E's/F's)

Wear seatbelt most of time or always
How often do you wear a seatbelt (Never; Rarely; Sometimes; Most of the time; Always)

Ever choose path based on safety
Do you ever choose your path because one way is safer than another (Yes; No; Don't Know)

Frequency to change direction because route seems unsafe
How often do you change direction because your route seem unsafe (Never; Daily; Weekly; Monthly)

Ever been jumped
Have you ever been jumped (Yes; No)

Ever in fistfight
Have you ever been in a fist fight? (Yes; No)

Know someone in jail or prison
Do you know anyone who has been on juvenile probation or in a juvenile detention center? (Yes; No)
If yes: Has anyone you know ever been on probation, in jail or in prison (Yes; No)

Ever been on juvenile probation
Have you ever been o probation or in juvenile detention? (Yes; No)

Ever been in jail or prison
If over age 18 or older: Have you ever been on probation, in jail or in prison? (Yes; No)

Ever been shot
Have you ever been shot (if firearm case, before today's injury)? (Yes; No)

Ever carried a weapon
Have you ever carried a gun, knife or club (Yes; No)

Ever carried a gun
If yes: What did you carry? (Gun; Knife; Club; Other)

Could get a gun
Could you get a gun? (Yes; No)

Drank alcohol in past 30 days
In the past 30 days, how often did you have at least one drink? (Free text response)

Smoked marijuana in past 30 days
In the past 30 days, how often did you smoke? (Free text response)

Ever sold drugs
Have you ever sold drugs? (Yes; No)

Neighborhood Environment scale
True/false
From my house I can walk to a park or playground where I enjoy myself playing sports or games.
There are plenty of safe places to walk or play/exercise outdoors in my neighborhood.
Every few weeks, some kid in my neighborhood gets beat up or mugged.
Every few weeks, some adult in my neighborhood gets beat up or mugged.
In my neighborhood, I see signs of racism and prejudice at least once a week.
In my neighborhood, many yards and alleys have broken bottles and trash lying around.
I have seen people using or selling drugs in my neighborhood.
In the morning or later in the day, I often see drunk people on the street in my neighborhood.
Most adults in my neighborhood respect the law.

Most people in my neighborhood respect the police.
There are abandoned or boarded-up buildings in my neighborhood.
I feel safe when I walk around my neighborhood during the day by myself.
I feel safe when I walk around my neighborhood at night by myself.
The people who live in my neighborhood often damage or steal each other's property.
The people who live in my neighborhood always take care of each other and protect each other from crime.
Almost every day I see homeless people walking or sitting around in my neighborhood.
In my neighborhood, the people with the most money are the drug dealers.
In my neighborhood, there are a lot of poor people who don't have enough money for food and basic needs.
For many people in my neighborhood, going to church, mosque, or temple on Sundays or religious days is a very important activity.
The people who live in my neighborhood are the best people in the world.

Things I Have Seen and Heard scale
True/false
I've heard gunshots.
I've seen someone get arrested.
I've seen drug deals.
I've seen someone get beat up.
My house has been broken into.
I've seen someone get stabbed.
I've seen someone get shot.
I've seen a gun in my home.
I've seen alcohol such as beer, wine, or liquor in my home.
I've seen gangs in my neighborhood,
I've seen someone pull a gun on somebody.
I've seen someone holding a gun.
I've seen someone in my home get shot or stabbed.

Generalized Self-Efficacy
True/false
I can solve tough problems.
I am confident.
I am smart.
I can solve most problems.
I can remain calm.
I can think of ways out of trouble.
I can usually handle whatever comes my way.
I am concerned about the crime that I see in my life every day.
I am scared of the crime that I see every day.
I am very good at handling disagreements with my family.
I am very good at handling disagreements with my friends.
I think that I can handle unsafe situations.
There are adults in my life that I look up to.
There are adults that I can go to that help me handle tough situations.

eTABLE 2. Source, year, coding, and format of data used to create surface layers representing environmental exposures in Philadelphia and hypothesized effect on risk of gunshot assault and non-gunshot assault (risk or protective).

Variable	Unit	Source	Description	Coding	Calculation	Min	Max	Mean (SD)	Med (25%, 75%)	Hypothesized effect
AlcExp	BG	Geolytics	Alcohol expenditures by households		Raster - IDW	0	986.8	366.2 (124.0)	358.9 (291.0, 433.4)	Risk
ao_all	Point*	Revenue	Alcohol outlets; all		Raster - KD	0	32	1.23 (2.27)	0 (0, 2)	Risk
ao_onon	Point*	Revenue	Alcohol outlets: bars, restaurants		Raster - KD	0	19	0.37 (1.14)	0 (0, 0)	Risk
ao_onoff	Point*	Revenue	Alcohol outlets: pizza places, stop-and-gos		Raster - KD	0	17	0.61 (1.18)	0 (0, 1)	Risk
ao_offoff	Point*	Revenue	Alcohol outlets: state stores, distributors		Raster - KD	0	5	0.25 (0.61)	0 (0, 0)	Risk
kden_fire	Point*	City of Phila.	Fire stations		Raster - KD	0	3.47	0.70 (0.86)	0.27 (0, 1.32)	Protective
kden_police	Point*	City of Phila.	Police stations		Raster - KD	0	6.99	0.55 (0.95)	0 (0, 0.78)	Protective
belong	CT	PHMC	Please tell me if you strongly agree, agree, disagree, or strongly disagree with the following statement: I feel that I belong and am a part of my neighborhood.	Proportion reporting strongly agree or agree.	Raster - IDW	0	0.98	0.85 (0.16)	0.88 (0.83, 0.92)	Protective
disorder	Point*	NIS	Disorderly Conduct (2400 series)		Raster - KD	0	85	3.7 (7.1)	2 (1, 4)	Risk
drunk		NIS	Public Drunkenness (2301)		Raster - KD	0	24	1.8 (2.9)	1 (1, 2)	Risk
improve	CT	PHMC	Have people in your neighborhood ever worked together to improve the neighborhood? For example, through a neighborhood watch, creating a community garden, building a community playground, or participating in a block party.	Proportion yes.	Raster - IDW	0	0.96	0.69 (0.18)	0.72 (0.60, 0.80)	Protective
mhhi	BG	Geolytics	Median household income		Raster - IDW	0	201563	31360 (17192)	27743 (20707, 49529)	
narc	Point*	NIS	All Narcotics Arrests (1800-1899)		Raster - KD	1	218	9.7 (14.5)	5 (2, 12)	Risk
neighbor	CT	PHMC	Using the following scale, please rate how likely people in your neighborhood are willing to help their neighbors with routine activities such as picking up their trash cans, or helping to shovel snow. Would you say that most people in your neighborhood	Proportion reporting always or often.	Raster - IDW	0	0.96	0.79 (0.16)	0.82 (0.76, 0.87)	Protective
particip	CT	PHMC	How many local groups or organizations in your neighborhood do you currently participate in such as social, political, religious, school-related, or athletic organizations?	# of organizations.	Raster - IDW	0	0.71	0.42 (0.11)	0.42 (0.37, 0.54)	Protective
gunshave	CT	PHMC	Are there any firearms, such as handguns, shotguns, or rifles in or around your home?	Proportion yes.	Raster - IDW	0	0.23	0.08 (0.04)	0.07 (0.05, 0.10)	Risk
PerCap16Unemp	BG	Geolytics	Unemployment (number of unemployed per 1,000 persons age 16+)		Raster - IDW	0	934.3	69.8 (84.4)	43.8 (14.1, 97,4)	Risk
PerCapBlack	BG	Geolytics	Per capita black population (number of blacks per 1,000 persons)		Raster - IDW	0	1000	494.4 (396.8)	428.4 (77.5, 957.7)	Risk
PerCapCollege	BG	Geolytics	Population with at least some college education		Raster - IDW	0	986.1	234.3 (166.9)	198.6 (123.5, 464.4)	Protective
PerCapHisp	BG	Geolytics	Per capita Hispanic population (number of Hispanics per 1,000 persons)		Raster - IDW	0	948.7	102.0 (181.0)	33.7 (12.4, 304.6)	Protective
PerCapInc	BG	Geolytics	Per capita income		Raster - IDW	0	425865	15980.9 (14125.1)	13914.5 (9748.5, 19282.0)	
Pop15_24	BG	Geolytics	Adolescent population (ages 15-24)		Raster - IDW	0	1234	116.8 (87.3)	101 (62, 152)	Risk
recctr	Point*	City of Phila.	Philadelphia recreation department facilities		Raster - KD	0	3790	783.5 (504.0)	704.5 (466.0, 992.5)	Risk

(continued below).

e**TABLE 2** (continued).

Variable	Unit	Source	Description	Coding	Calculation	Min	Range	Mean (SD)	Med (25%, 75%)	Hypothesized effect
stress	CT	PHMC	Using a scale from 1 to 10, where 1 means "no stress" and 10 means "an extreme amount of stress", how much stress would you say you have experienced during the past year?	Visual analog scale, range of 1-10.	Raster - IDW	0	0.59	0.34 (0.09)	0.35 (0.30, 0.39)	Risk
trust	CT	PHMC	Please tell me if you strongly agree, agree, disagree or strongly disagree with the following statement: Most people in my neighborhood can be trusted.	Proportion reporting strongly agree or agree.	Raster - IDW	0	0.98	0.65 (0.20)	0.67 (0.53, 0.81)	Protective
vacant	Point*	NIS	Vacant properties		Raster - KD	0	377	25.3 (38.0)	11 (3, 31)	Risk
vandalism	Point*	NIS	Vandalism and Criminal Mischief (1400 series)		Raster - KD	0	55	8.3 (7.2)	7 (3, 12)	Risk
violence	CT	PHMC	Thinking about the past year, have you been subject to any kind of physical violence by friends, family members or strangers such as being shoved, slapped, beaten, forced into sexual activity or threatened, or hurt with a knife or gun?	Proportion yes.	Raster - IDW	0	0.07	0.02 (0.001)	0.02 (0.02, 0.03)	Risk
truancy	BG	Phila. Dept. of Ed.	Truancy rate, average among schools		Raster - KD	0	147.5	4.5 (13.7)	0 (0, 20.2)	Risk

* Data obtained in point location format were treated as points when calculating exposure surface layers (i.e., kernel density) but were aggregated into block groups to present descriptive statistics here.

For variables for which multiple years of data were available, summary statistics are based on the most recent data year.

PHMC: Philadelphia Health Management Corporation's Southeastern Pennsylvania Household Survey (mean number of respondents per census tract is approximately 130). NIS: Neighborhood Information System at the University of Penn Cartographic Modeling Lab.

CT: census tract. BG: block group. IDW: inverse distance weighting. KD: kernel density.

eTABLE 3. Six factors representing environmental constructs derived through factor analysis of 27 variables representing the built and social environment.

Factor	Variable	Factor loading 1	2	3	4	5	6	Expected correlation with violence
1. Neighbor connectedness								–
	belonging[1]	0.9						–
	improve[1]	0.8						–
	neighbors[1]	0.9						–
	participation[1]	0.8						–
	stress[1]	0.5						+
	trust[1]	0.5						–
2. Income								–
	median household income		0.9					–
	per capita income		0.8					–
	unemployment		-0.5					+
	alcohol expenditures		0.9					+
3. Alcohol outlets, drunkenness,								+
disorderly conduct	on-premise alcohol outlets			0.9				+
	off-premise alcohol outlets			0.8				+
	disorder arrests			0.7				+
	drunkenness arrests			0.9				+
4. Vacancy, vandalism, violence								+
	narcotics arrests				0.8			+
	% college education				-0.7			–
	vacant properties				0.5			+
	vandalism				0.7			+
	violence				0.7			+
5. Fire stations, police stations								–
	fire stations					0.9		–
	police stations					0.8		–
6. Race, ethnicity								–
	% population African American						-0.6	+
	% population Hispanic						0.8	–
	Eigenvalue:	5.9	4.3	3.0	1.7	1.5	1.2	
	% of variance explained:	18%	17%	17%	17%	10%	8%	

Environmental variables that did not load on a factor were household gun ownership[1], percent of the population between 15-24 years old, recreation centers, and truancy.

1. Survey question from the Southeastern Pennsylvania Household Health Survey (details below).

belong: "Please tell me if you strongly agree, agree, disagree, or strongly disagree with the following statement: I feel that I belong and am a part of my neighborhood." Proportion reporting strongly agree or disagree.

improve: "Have people in your neighborhood ever worked together to improve the neighborhood? For example, through a neighborhood watch, creating a community garden, building a community playground, or participating in a block party." Proportion yes.

neighbor: "Using the following scale, please rate how likely people in your neighborhood are willing to help their neighbors with routine activities such as picking up their trash cans, or helping to shovel snow. Would you say that most people in your neighborhood." Proportion reporting always or often.

participation: "How many local groups or organizations in your neighborhood do you currently participate in such as social, political, religious, school-related, or athletic organizations?" Number of organizations.

gunshave: "Are there any firearms, such as handguns, shotguns, or rifles in or around your home?" Proportion yes.

stress: "Using a scale from 1 to 10, where 1 means 'no stress' and 10 means 'an extreme amount of stress', how much stress would you say you have experienced during the past year?" Visual analog scale, range of 1-10.

trust: "Please tell me if you strongly agree, agree, disagree or strongly disagree with the following statement: Most people in my neighborhood can be trusted." Proportion reporting strongly agree or disagree.

eTABLE 4. Results of adjusted case-control analysis comparing gunshot and non-gunshot case subjects' levels of exposure to individual and situational circumstances, climate characteristics, and environmental contexts at the time of being assaulted relative to time-matched controls, by age group.

	Gunshot wound assault				Non-gunshot wound assault			
	≥18 years		<18 years		≥18 years		<18 years	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual and situational								
Alone	2.1	(1.7 , 2.5)	1.2	(0.3 , 4.5)	0.9	(0.3 , 3.4)	1.6	(0.6 , 4.6)
Location								
Indoors	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --
Outdoors on foot	6.6	(2.1 , 21.2)	55	(0.7 , 4357)	1.7	(0.8 , 3.5)	2.5	(1.5 , 4.3)
Car	3.8	(0.8 , 17.7)	731	(1.3 , 418653)	0.2	(0.1 , 0.7)	0.2	(0.0 , 3.7)
Bus	0.1	(0.0 , 0.1)	0.1	(0.0 , 0.1)	0.1	(0.0 , 0.1)	0.8	(0.1 , 7.0)
Trolley	0.1	(0.0 , 0.1)	0.1	(0.0 , 0.1)	9.0	(2.8 , 29.5)	0.1	(0.0 , 0.1)
Weapon carrying								
None	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --
Gun	1.3	(0.6 , 2.9)	n/a[c]	(n/a , n/a)	n/a[1]	(n/a , n/a)	n/a[c]	(n/a , n/a)
Other	0.8	(0.2 , 4.3)	n/a[c]	(n/a , n/a)	n/a[2]	(n/a , n/a)	n/a[c]	(n/a , n/a)
Alcohol consumption	0.8	(0.3 , 2.1)	n/a[c]	(n/a , n/a)	5.6	(2.4 , 13.3)	n/a[c]	(n/a , n/a)
Climate								
Precipitating	2.9	(1.8 , 4.8)	1.5	(0.5 , 4.4)	1.5	(0.4 , 4.8)	0.4	(0.2 , 0.6)
Environment								
Neighbor connectedness[a]	0.7	(0.6 , 0.8)	0.1	(0.0 , 1.3)	0.7	(0.5 , 0.8)	0.6	(0.5 , 0.9)
Income[a]	0.6	(0.3 , 1.1)	2.8	(1.2 , 6.8)	1.6	(0.9 , 2.4)	1.5	(1.0 , 2.6)
Alcohol & social incivilities[a]	0.7	(0.4 , 1.1)	0.2	(0.0 , 377)	1.0	(0.7 , 1.2)	0.8	(0.3 , 2.2)
Vacancy, violence & vandalism[a]	1.7	(1.1 , 2.7)	44	(0.8 , 2407)	1.5	(1.1 , 2.0)	2.1	(1.2 , 3.6)
Fire & police stations[a]	1.5	(1.4 , 1.7)	7.5	(3.1 , 18.8)	1.1	(0.8 , 1.5)	1.0	(0.8 , 1.3)
Race & ethnicity[a]	0.8	(0.6 , 0.9)	1.0	(0.1 , 13.8)	1.1	(0.9 , 1.4)	1.2	(1.0 , 1.6)
Recreation centers[b]	1.1	(0.9 , 1.3)	3.0	(0.9 , 9.5)	1.1	(0.8 , 1.6)	1.6	(1.2 , 2.2)
Gun ownership[b]	2.0	(1.5 , 2.8)	5.7	(2.8 , 11.5)	0.8	(0.6 1.1)	0.7	(0.5 1.0)
Population 15-24[b]	1.2	(0.9 , 1.7)	2.5	(0.5 , 12.6)	1.3	(1.0 , 1.8)	1.3	(1.0 , 1.8)
Truancy[b]	0.6	(0.4 , 1.0)	0.3	(0.0 , 2.3)	1.0	(0.5 , 1.7)	1.3	(0.9 , 2.0)

OR: odds ratio. CI: confidence interval. n/a: not applicable. ref: reference category.

Modelled with conditional logistic regression stratified by time of day and adjusted for age, day of week and month.

[a] Indicates a factor representing a construct derived from multiple variables.

[b] Indicates that the item is a single variable as opposed to a composite item (i.e., factor).

n/a[c] Could not estimate.

eTABLE 5. Results of adjusted case-crossover analysis comparing gunshot and non-gunshot case subjects' levels of exposure to individual and situational circumstances, climate characteristics, and environmental contexts at the time of being assaulted relative to times preceding the assault, by age group.

	Gunshot wound assault				Non-gunshot wound assault			
	≥18 years		<18 years		≥18 years		<18 years	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual								
Alone	1.2	(0.8 , 1.7)	0.7	(0.3 , 1.9)	0.9	(0.6 , 1.4)	0.9	(0.5 , 1.4)
Location								
Indoors	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --
Outdoors on foot	4.4	(2.4 , 7.9)	5.2	(1.6 , 17.6)	3.0	(1.6 , 5.8)	2.6	(1.6 , 4.1)
Car	2.0	(1.3 , 3.1)	3.2	(1.6 , 6.5	0.6	(0.2 , 1.7)	0.5	(0.1 , 1.5)
Bus	1.7	(1.3 , 2.2	2.1	(0.9 , 5.1)	1.1	(0.9 , 1.4)	0.9	(0.7 , 1.2)
Trolley	1.3	(1.1 , 1.4	1.2	(0.9 , 1.7	1.3	(1.1 , 1.5)	1.0	(0.8 , 1.1)
Weapon carrying								
None	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --	*-ref-*	-- --
Gun	1.4	(1.2 , 1.7)	n/a[c]	(n/a , n/a)	n/a[c]	(n/a , n/a)	n/a[c]	(n/a , n/a)
Other	1.0	(0.6 , 1.5)	n/a[c]	(n/a , n/a)	n/a[c]	(n/a , n/a)	n/a[c]	(n/a , n/a)
Alcohol consumption	0.6	(0.2 , 1.9)	n/a[c]	(n/a , n/a)	1.1	(0.8 , 1.4)	n/a[c]	(n/a , n/a)
Climate								
Precipitating	1.2	(0.7 , 1.9)	8.3	(1.1 , 64.9)	1.2	(0.6 , 2.1)	0.9	(0.6 , 1.3)
Environment								
Neighbor connectedness[a]	1.0	(0.6 , 1.5)	3.2	(0.2 , 62.3)	0.9	(0.7 , 1.4)	0.7	(0.5 , 1.0)
Income[a]	0.7	(0.5 , 1.1)	0.5	(0.0 , 19.1)	2.1	(1.3 , 3.6)	0.7	(0.4 , 1.4)
Alcohol & social incivilities[a]	1.0	(0.8 , 1.4)	0.7	(0.1 , 7.0)	0.7	(0.5 , 1.0)	1.2	(0.6 , 2.4)
Vacancy, violence & vandalism[a]	1.7	(1.1 , 2.8)	1.8	(0.1 , 41.2)	4.7	(1.8 , 11.9)	1.6	(0.9 , 3.1)
Fire & police stations[a]	1.1	(0.8 , 1.7)	2.1	(0.5 , 8.0)	0.9	(0.4 , 1.7)	0.7	(0.4 , 1.2)
Race & ethnicity[a]	0.9	(0.7 , 1.1)	1.9	(0.1 , 31.4)	2.7	(0.9 , 7.8)	1.9	(0.9 , 4.2)
Recreation centers[b]	1.1	(0.8 , 1.6)	1.0	(0.5 , 2.0)	0.8	(0.4 , 1.8)	1.2	(0.7 , 2.3)
Gun ownership[b]	0.9	(0.5 , 1.5)	9.0	(1.0 , 84.8)	1.1	(0.8 , 1.7)	0.3	(0.1 , 0.9)
Population 15-24[b]	1.5	(0.9 , 2.3)	3.7	(0.5 , 28.9)	1.1	(0.6 , 2.0)	0.6	(0.3 , 1.1)
Truancy[b]	0.8	(0.5 , 1.2)	0.4	(0.1 , 1.3)	0.9	(0.5 , 1.8)	2.8	(1.6 , 5.0)

OR: odds ratio. CI: confidence interval.

Modelled with conditional logistic regression stratified by subject.

[a] Indicates a factor representing a construct derived from multiple variables.

[b] Indicates that the item is a single variable as opposed to a composite item (i.e., factor).

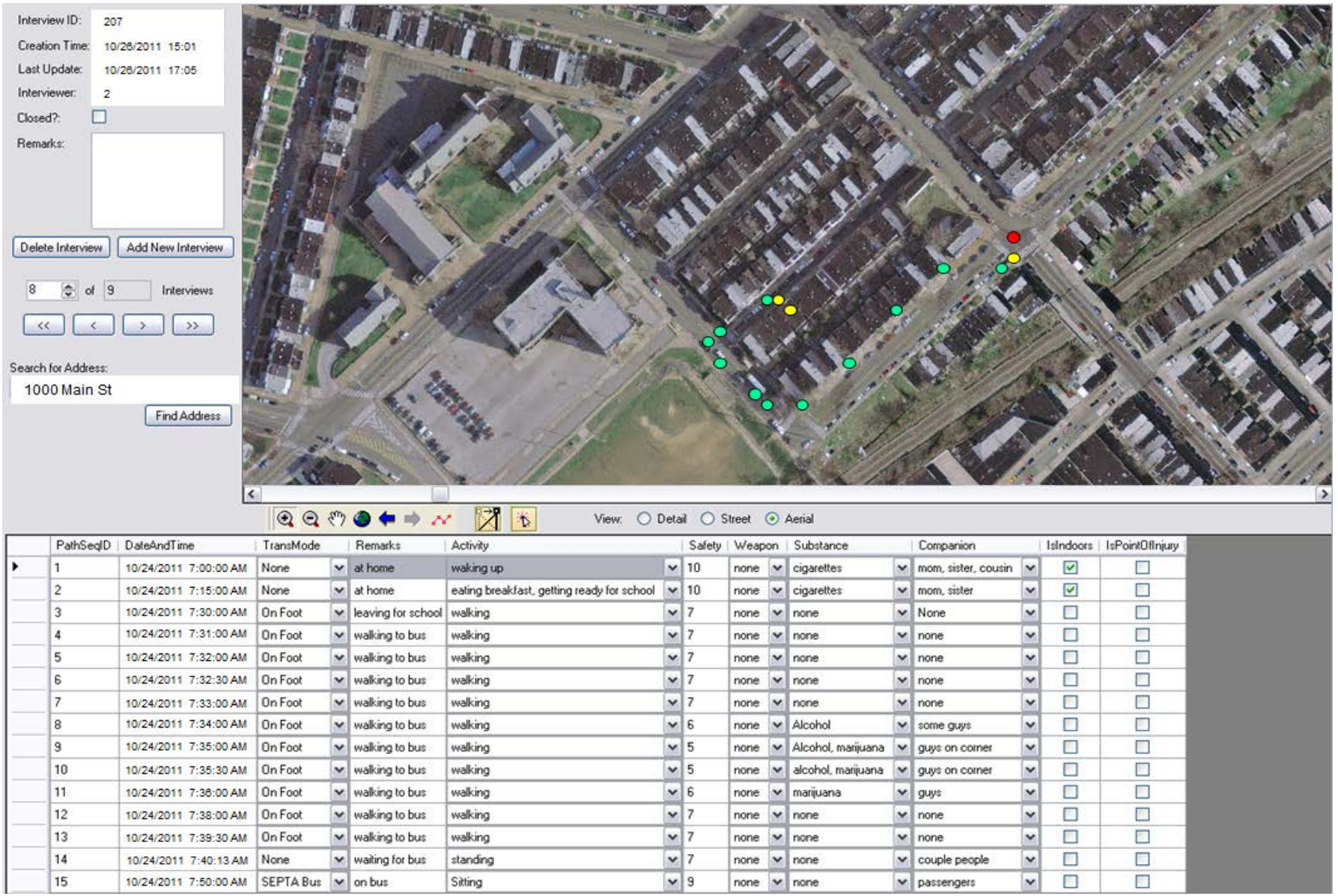
n/a[c] Could not estimate.

eTABLE 6. Within-subject correlation between levels of exposure to environmental characteristics that were present in the locations where subjects lived and the mean levels of exposure experienced during daily activities.

	Gunshot cases	Non-gunshot cases	Controls
Neighbor connectedness[a]	0.8	0.8	0.8
Income[a]	0.6	0.6	0.7
Alcohol & social incivilities[a]	0.7	0.4	0.4
Vacancy & vandalism[a]	0.7	0.7	0.8
Fire & police stations[a]	0.8	0.6	0.7
Race & ethnicity[a]	0.7	0.6	0.8
Recreation centers[b]	0.8	0.6	0.7
Gun ownership[b]	0.8	0.8	0.9
Population 15-24[b]	0.8	0.7	0.7
Truancy[b]	0.8	0.6	0.7

[a] Indicates a factor representing a construct derived from multiple variables.

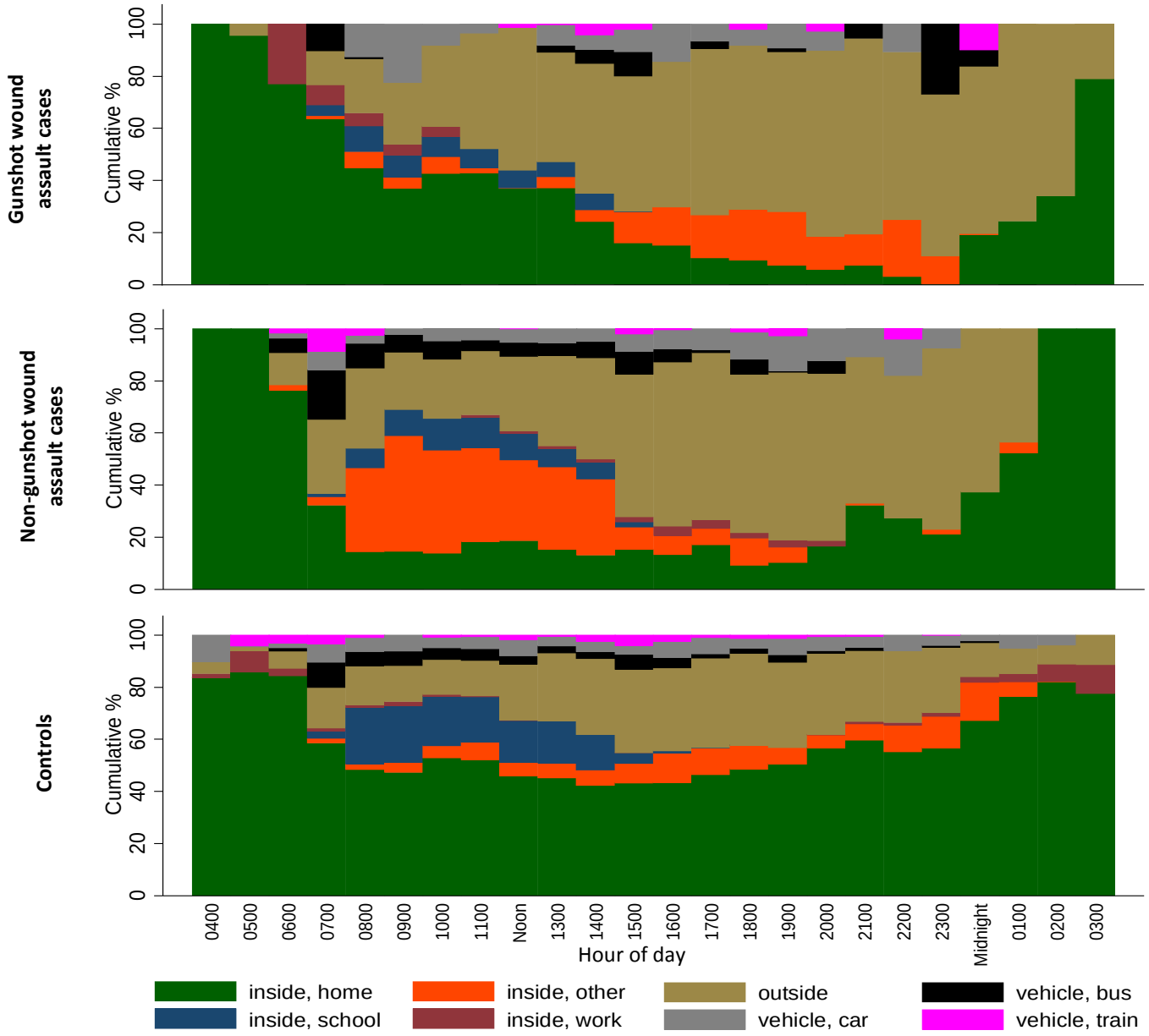
[b] Indicates that the item is a single variable as opposed to a composite item (i.e., factor).



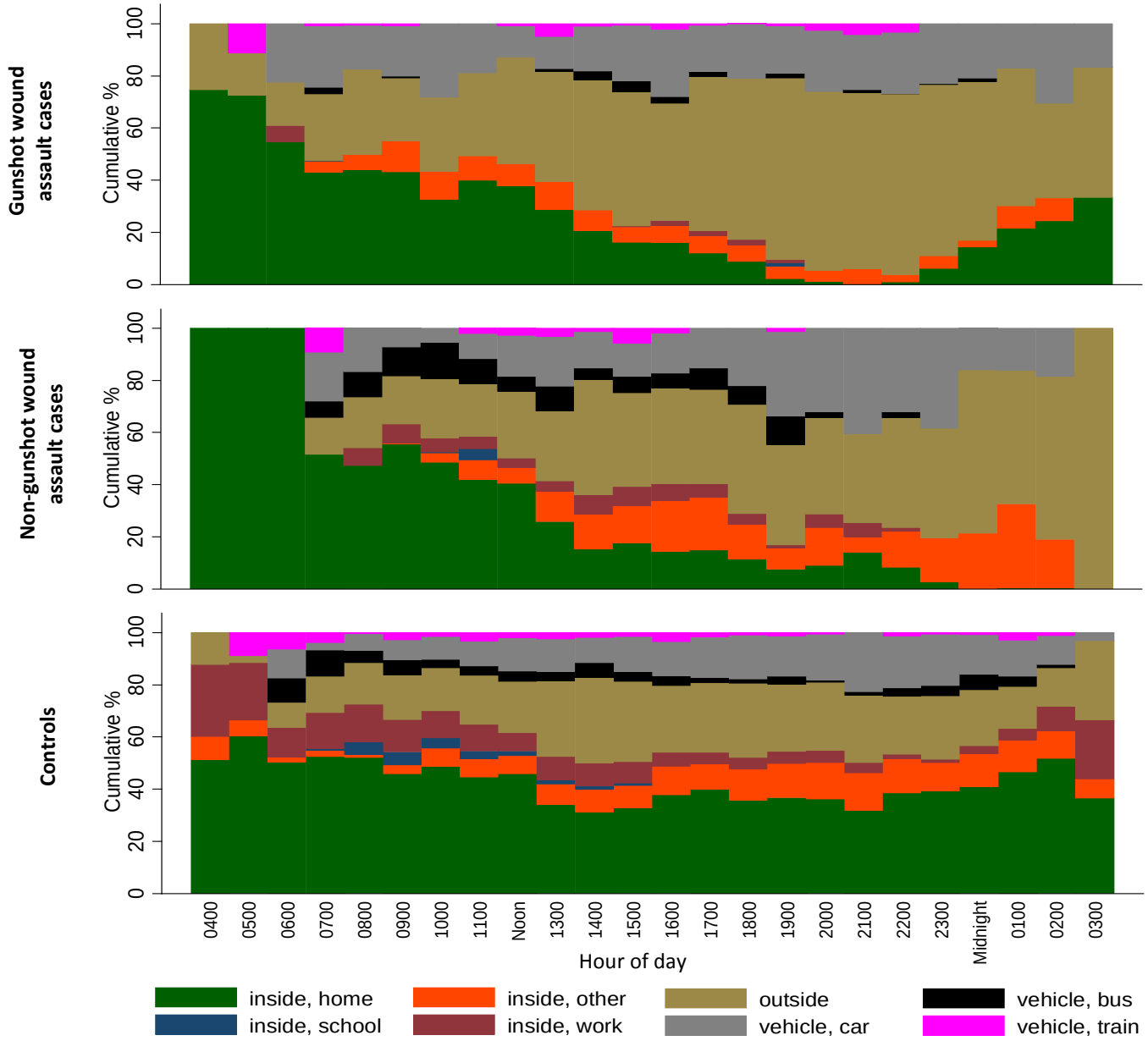
	PathSeqID	DateAndTime	TransMode	Remarks	Activity	Safety	Weapon	Substance	Companion	IsIndoors	IsPointOfInjury
▶	1	10/24/2011 7:00:00 AM	None	at home	waking up	10	none	cigarettes	mom, sister, cousin	☑	☐
	2	10/24/2011 7:15:00 AM	None	at home	eating breakfast, getting ready for school	10	none	cigarettes	mom, sister	☑	☐
	3	10/24/2011 7:30:00 AM	On Foot	leaving for school	walking	7	none	none	None	☐	☐
	4	10/24/2011 7:31:00 AM	On Foot	walking to bus	walking	7	none	none	none	☐	☐
	5	10/24/2011 7:32:00 AM	On Foot	walking to bus	walking	7	none	none	none	☐	☐
	6	10/24/2011 7:32:30 AM	On Foot	walking to bus	walking	7	none	none	none	☐	☐
	7	10/24/2011 7:33:00 AM	On Foot	walking to bus	walking	7	none	none	none	☐	☐
	8	10/24/2011 7:34:00 AM	On Foot	walking to bus	walking	6	none	Alcohol	some guys	☐	☐
	9	10/24/2011 7:35:00 AM	On Foot	walking to bus	walking	5	none	Alcohol, marijuana	guys on corner	☐	☐
	10	10/24/2011 7:35:30 AM	On Foot	walking to bus	walking	5	none	alcohol, marijuana	guys on corner	☐	☐
	11	10/24/2011 7:36:00 AM	On Foot	walking to bus	walking	6	none	marijuana	guys	☐	☐
	12	10/24/2011 7:38:00 AM	On Foot	walking to bus	walking	7	none	none	none	☐	☐
	13	10/24/2011 7:39:30 AM	On Foot	walking to bus	walking	7	none	none	none	☐	☐
	14	10/24/2011 7:40:13 AM	None	waiting for bus	standing	7	none	none	couple people	☐	☐
	15	10/24/2011 7:50:00 AM	SEPTA Bus	on bus	Sitting	9	none	none	passengers	☐	☐

eFIGURE 1. Screen shot of data collection mapping application.

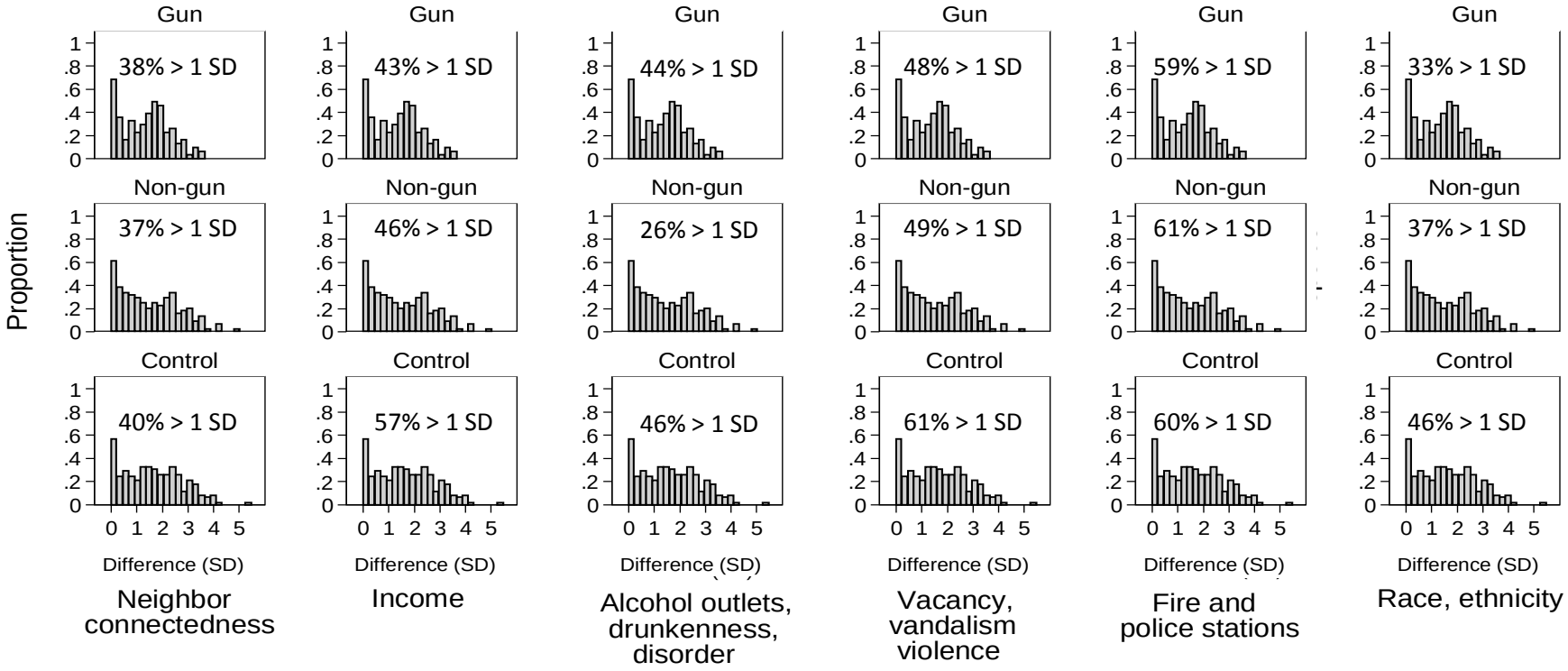
Note: data are hypothetical since individuals' location-specific data are never shown for confidentiality.



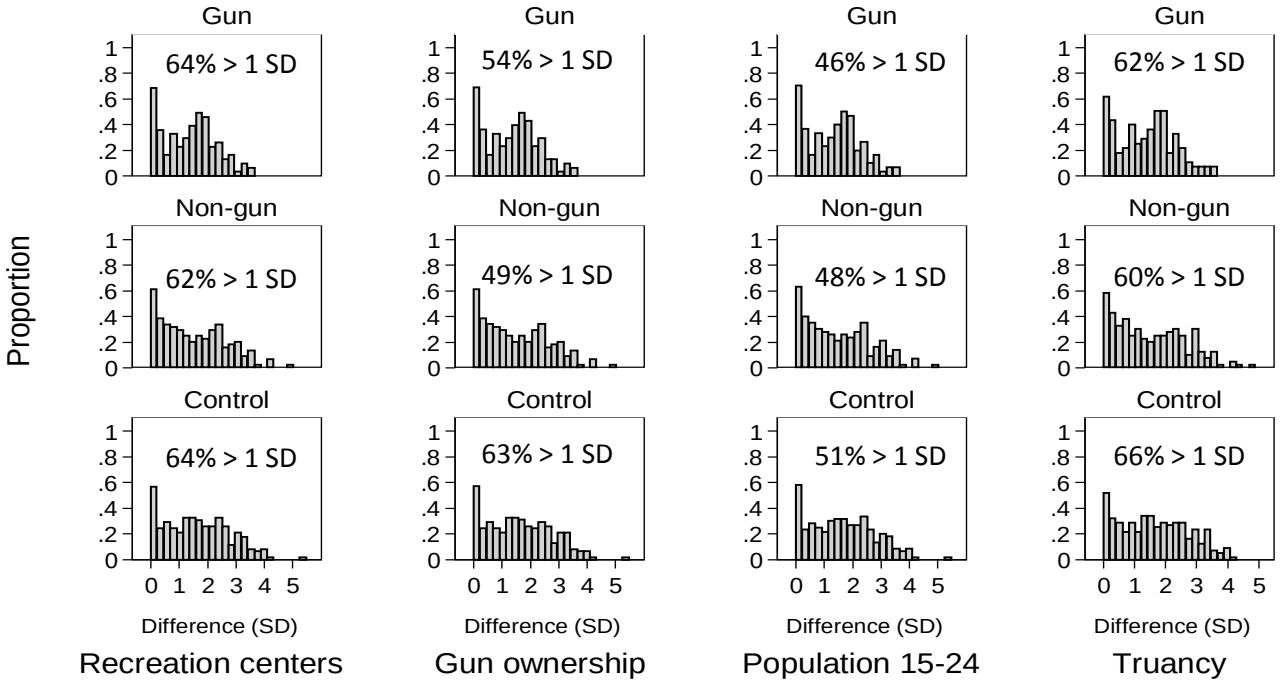
eFIGURE 2. Percent of time during each hour of the day that 10-18 year-old subjects spent in different types of locations and modes of transportation, by subject group.



eFIGURE 3. Percent of time during each hour of the day that 19-24 year-old subjects spent in different types of locations and modes of transportation, by subject group.



eFIGURE 4. Differences, in standard deviation units, between the maximum and minimum level of exposure to features of the environment experienced by subjects during daily activities, as measured by six composite factors. Each figure is a histogram showing the proportion of subjects who experienced a given absolute difference in exposure to one of the six factors. The number in each figure is the proportion of subjects who experienced a highest level of exposure to a factor that was at least one standard deviation greater than the lowest level of exposure to the factor.



eFIGURE 5. Differences, in standard deviation units, between the maximum and minimum level of exposure to features of the environment experienced by subjects during daily activities, as measured by four variables. Each figure is a histogram showing the proportion of subjects who experienced a given absolute difference in exposure to one of the four variables. The number in each figure is the proportion of subjects who experienced a highest level of exposure to a variable that was at least one standard deviation greater than the lowest level of exposure to the variable.

eAPPENDIX 1

INTRODUCTION

A 1951 study, *One Boy's Day: A Specimen Record of Behavior*, is a heuristic for our approach.[7] In that study, trained observers, with the cooperation of parents, teachers, and others, took turns personally observing the travels of a seven year-old research subject throughout the course of his activities for 14 consecutive hours. Their goal was to document the nature of the subject's interactions with different people, places, and situations. The study included photographs, maps of environmental conditions, and detailed documentation and step-by-step accounts such as the subject idly taking an unspent firearm cartridge from his pants pocket just after eating breakfast, encountering a pair of snarling dogs as he approached his school, and walking along the peak of a steeply sloped roof during play.

This detail-laden study of a single child's day was groundbreaking for its time. It was our intent to produce an analogous epidemiologic work, albeit with new technology and for hundreds of boys, adolescents, and young men, focusing on their daily risks of violent assault.

eAPPENDIX 2

METHODS

Recruitment and Enrollment. We sought a control group that would be representative of the population that gave rise to the cases. Approximately 90% of the young assault patients treated at the study hospitals reside in an area comprised of 12 contiguous ZIP codes in which the hospitals are centrally located. The population in this catchment area of these hospitals has a median household income of $26,314 and 49% of households are female headed (compared to $32,248 and 45% respectively for Philadelphia overall), is 61% African American and 2% Hispanic (compared to 40% and 7% respectively in Philadelphia overall), and 16% of adults age 25 years or older have a college education (compared to 22% in Philadelphia overall).[28] Control recruitment from this area was stratified to ensure adequate sample size by age group (10-14, 15-18, and 19-24 years).

Interview and Collection of Space-Time Activity Data. Separately, we accessed results from African American youth in Pennsylvania who responded to the 2011 Youth Risk Behavior Survey (YRBS).[29] We used this to compare the responses to the YRBS questions about risk taking to the responses that control group subjects of the same ages gave to items that were similar. This approach helped us assess whether the control group that we enrolled was representative of the population that we were aiming to recruit.

GIS-Assisted Interview Protocol. We have provided a screen shot of the data collection application as it appeared on the screen of a laptop computer as an interview took place (see eFigure 1, showing a screenshot). This application is run in a customized version (Azavea, Philadelphia, Pennsylvania) of ArcEngine software (ESRI, Inc., Redlands, California) developed for this study. During an interview, the application showed a detailed street map of the subject's residential area as well as, when zoomed out, the entirety of Philadelphia, and contained a high-resolution color satellite photo of Philadelphia that could be toggled to for an alternate view. The interviewer worked with the subject to scroll to the location of the subject's home. The subject was then asked to report sequentially his daily activities by location and time, starting with the time he woke up in the morning. Using the mouse to draw points on the street map, the interviewer created a graphic that provided a minute-by-minute record of how, when, where, and with whom the subject spent time over the course of the full day (until assaulted or going to bed, for a duration of up to 24 hours) as he walked or otherwise traveled from location to location and from activity to activity. We processed the data such that the activity path record for each subject consisted of a point on the map for each 10-minute period of their activity, as described below.

Processing the GIS data for analysis. During the GIS-assisted portion of the interview, as the subject tells the interviewer where he woke up and points to a house, the interviewer clicks the screen, which puts the first point at that location on the map. Point 1 corresponds to row 1 in the table (shown in eFigure 1). The subject proceeds by "walking the interviewer through his day," with the interviewer putting new points as

frequently as required to track locations and changes in events accurately. At each point he reports his status on the topics denoted by each table column, including time, transportation mode, activity, feeling of safety from perceived risk of assault (10=very safe, 1=very unsafe), weapon carrying, substance use by subject or others, and companions. The latitude and longitude of each point is recorded automatically in the background of the application as the point is created. Whether the point occurred indoors or outdoors is also recorded, as is the point at which the subject was assaulted (used for case subjects only). The color of each point corresponds to the subject's mode of transportation as a way to build in some context, which we find helps both the subject and interviewer work methodically to build a complete history of the subject's daily activities. Also, we designed the application so that each time a new point is created, the map re-centers on that point. This feature lets the interviewer create points quickly, without needing to scroll the map horizontally or vertically, in instances when a subject reports travelling consistently in one direction over a considerable distance to locations that were initially outside the field of view.

The interviewer sets the time of day for the first point according to the subject's report. For points created subsequently, the time column is auto-populated using an algorithm based on the mode of transportation designated for a given point and its street-line distance from the previous point. This speeds the interview process, but the interviewer frequently asks the subject to report his estimate of the time of day that corresponds to new points. When a discrepancy occurs and the auto-time value is inaccurate, the interviewer overrides the value. The auto-function starts calculating again

from that point. We find this very useful for keeping the subject engaged in recalling the nature and times of their events.

Processing the Data on Paths of Daily Activities. We chose our method of plotting a new point on the map only when a subject reported a change in their location or a change in their activity (e.g., a companion joined the subject while the subject was stationary at a location) because it is an efficient way to obtain and document a considerable volume of detailed information from each subject. Using this method, consider if a subject reports travelling on foot, turning a corner onto a different street, and then walking straight along the street for 10 minutes, traveling 1 mile before stopping to wait for a friend. That segment of the subject's day is recorded using only 2 points, one where he turned the corner onto the street and started walking and one where he stopped. Later, when this subject's path is appended with mapped data on the Philadelphia environment as is described below, the data table is such that it contains no information about location-specific exposures the subject encountered between those 2 points during these 10 minutes of his day. That is, we recorded nothing about the things he walked past (e.g., a recreation center). Thus a next step is involved in preparing the path data. The recorded history of each subject's path consists of multiple points, where each point is represented by a unique observation (row) in a table and the data for each point includes the time (date, hour, minute) it took place. We restructure each subject's record by inserting new rows to result in a new record for each subject that has one observation (row) for each minute of the subject's reporting period. Thus, each of the new observations in a subject's record includes a time of occurrence but does not include a

location of occurrence. Using ArcGIS software (ESRI, Inc.), we overlay this modified record on a street map of Philadelphia and generate the latitude and longitude coordinates for each of the newly created observations. The coordinates are derived by estimating where on the map, between two original points, the subject would have been at that time as a function of their travel speed. In this example, because the subject walked for 10 minutes before stopping, 9 new points, spaced at equal intervals, are created between the subject's first and last point in that segment of the subject's original record.

After this procedure, the working data record for each subject is comprised of one row representing each minute during the activity path reported by a given subject. If a subject's activity path spanned 10 hours his record contains 600 rows of data. Note that as each interview takes place, the subject reports who they were with and what they were doing each time the interviewer records a new point in the original activity path record. As noted above, our interview protocol calls for creating a new point each time the subject reports a change in status in terms of location or each of the activities and behaviors represented by the fields in the table of the mapping application. This implies that no changes in a subject's activity status occurred at times between the instances when new points are created. Because of this, during the data management process we code each newly created point to have the same activity status information that appears in the original point that most immediately precedes the new point. That is, we carry activity information forward in time for the points between original points.

This procedure results in a minute-by-minute record of each subject's activities over periods of up to 24 hours. During the interview though, whereas the subject recounts their path in a way that had high geographic specificity (each subject makes an effort to

show the interviewer exactly the continual path he travelled) the interviewer records points only at select locations along that path. Thus the table of data that each interview yields is formatted in a way where temporal specificity is relatively low. The process we use to expand each subject's record to have one point for each minute of experience is performed because the mechanics of doing so make the data record more accurately reflect the level to which the subject was exposed to features of the environment at all the locations along the subject's path that he travelled through or spent any amount of time. However, doing so creates a dataset containing 456,000 observations – about 750 minute-specific observations on average per subject. This frequency higher than is needed for testing the hypotheses in this study. As described in the manuscript, to each path point we attach data about characteristics of the built and social environment that is present at the location of each point. Because those data are comprised of smoothed surface layers, when attached to the minute-specific point data there is considerable temporal autocorrelation, with values of adjacent points being more similar than values of points that are further separated in time. Thus adjacent points contain redundant information about the extent to which subjects were exposed to features of the environment. We therefore keep only every tenth record of each subject's path. Thus in the analyses described below, each subject's activity path consists of one observation for every 10 minutes that had elapsed over the course of the activity period they reported.

For each point we kept in the working data record, the value it is assigned for each of variables about the nature of the subject's activities (i.e., the aspects represented by the fields in the mapping application) is the value the subject had reported for that actual point, or if the point is an interstitial point that we created, is the value the subject

reported for the original point that had been most recently reported. In addition to having this individual-level data each record, below we describe that we append each point with values that represent the extent to which the subject, while in that specific location, was exposed to risk or protective factors that are defined according to features of his environment. For each of these environmental variables, the point we keep is assigned a value equal to the median level of exposure observed for the 9 points immediately preceding the index point (the value of the index point is included in the median calculation). In this way, we derive variables that provide time-weighted estimates of the extent to which each subject was exposed at any and all times over the course of their reported periods of activity.

Measuring the Landscape of Each Subject's Activities. The data from the Cartographic Modelling Lab consisted of geographically-specific information from the U.S. Census, the Philadelphia Housing Authority, the Philadelphia Police Department, the Philadelphia Health Management Corporation's Southeastern Pennsylvania Household Health Survey, and the Neighborhood Information System, which contains parcel-level (i.e., unit-level) information on abandonment and vacancy, commercial land uses, real estate sales and neighborhood conditions for over 560,000 parcels in Philadelphia.

Each geographic variable was originally in either point or polygon format, and thus was geographically referenced with a pair of latitude and longitude coordinates (either explicitly or as a geographic centroid for Census block groups, for example). We converted these point and polygon data to raster map layers, and used the raster data for

analysis rather than the original point and polygon format, to avoid their inherent problems of boundary effects and the modifiable areal unit problem.[30-36]

Questions on the Southeastern Pennsylvania Household Health Survey, such as the "improve" question described in the manuscript, had ordinal response options. We converted responses to the questions into raster map layers by recoding ordinal scale responses into a dichotomous outcome (0/1), calculating the proportion coded 1 per Census tract, and transforming the Census tract data into raster. Other questions that elicited a count or continuous outcome were converted to raster directly.

The weather data that we accessed were date-specific hourly weather data from the National Weather Service.

Descriptive Statistics. To investigate whether there was variability in the extent to which subjects became exposed to features of the environment as they carried out daily activities, we converted the data for each feature of the environment into a factor item or, for variables that did not load on a factor, a z-score (i.e., standardized, having a mean of 0, standard deviation of 1). Then for each subject, we determined the highest level and the lowest level of exposure that they experienced to each feature of the environment. We then calculated a variability value for each subject as the difference between those two values. We report these standard deviation unit difference scores separately for each case subject group and for the control subject group, to indicate the proportion of subjects who experienced little, moderate, or substantial variability in the prevalence of a given feature of the environment that was present in the locations where the individuals travelled or spent time (eFigure 4 and eFigure 5). Also, we used Pearson correlation coefficients to

explore whether the prevalence of each environmental feature in the location where subjects lived was correlated with the mean level of exposure that the subject experienced during their daily activities (eTable 6).

Regression Analysis.

Regression Part 2. Note that by comparing each case, at the time of the assault, against himself earlier that day, the advantage of this approach is that it let us eliminate confounding by case subject characteristics that remain constant and that may pose a risk of violence but are not readily measurable (e.g., impulsivity), and then derive effect estimates for insight into whether the risk of being assaulted stems from things young people did and from characteristics of places where they spent time. We chose to carry out this alternative approach, that involved differencing the data for each case subject, given the possibility that even if case subjects were exposed to an extreme level at the time they were assaulted as compared to prior to that time, those levels may nevertheless be moderate when compared to levels experienced by controls. If that scenario occurred, failing to difference the data could lead to erroneous conclusions about risk factors for assault. As a check of this new approach, we also used a basic alternative by conducting a basic case-crossover design that did not involve data from controls and, instead, simply compared each subject at the time they were assaulted to observations taken on themselves prior to the time when they were assaulted.[23]

eAPPENDIX 3

RESULTS

Characteristics of Subjects.

Table 1 shows that it was common for subjects to have carried a weapon of some type, with 46% of gunshot cases, 26% of non-gunshot cases, and 39% of controls reporting having done so. Also, 29%, 10%, and 17% of subjects, respectively, had ever carried a gun.

Over one-third of gunshot case subjects (38%) and controls (34%) and one fifth (23%) of non-gunshot cases had consumed alcohol in the past 30 days. Having smoked marijuana in the past 30 days was common among gunshot cases (50%), non-gunshot cases (45%), and controls (42%).

The comparable characteristics about risk taking that were evaluated among youth in Pennsylvania interviewed on the Youth Risk Behavior Survey indicate 24% rarely or never wore a seatbelt, 55% had been in a fight in the past 12 months, and in the past 30 days 29% had consumed alcohol, 21% had used marijuana, 15% had carried a weapon, and 8% had carried a gun. Limiting our analysis to control subjects in the same age group indicated that 23% rarely or ever wore seatbelt, 93% had ever been in a fight, in the past 30 days 17% had consumed alcohol and 34% had used marijuana, and 27% had ever carried a weapon and 9% had ever carried a gun.

Table 1 also reports that there was no difference across groups in terms of reports on the Neighborhood Environment Scale, where higher values indicate a greater degree of neighborhood disadvantage.[37] Gunshot cases, however, scored higher than controls on the Things I Have Seen and Heard scale, where higher values represent higher levels of

exposure to neighborhood disorder and violence.[38] Non-gunshot cases scored lower than controls on the Generalized Self-Efficacy scale.[39]

As reported in the manuscript, the areas where subjects' homes were located were similar in median household income, unemployment rate, and prevalence of Hispanic population. Gunshot cases, however, resided in areas where college education was less common compared to controls and vacant properties were more common compared to controls, and non-gunshot cases resided in areas where the prevalence of African American population was lower compared to controls.

Activity Path Analysis.

Travel distance and time and proximity to home. Each day of the week was represented among the activity paths reported by gunshot, non-gunshot, and control subjects. The median duration of activity paths reported by gunshot, non-gunshot, and control subjects was 11 hours (IQR 8-15), 9 hours (IQR 6-13), and 15 hours (IQR 12-17), respectively. Viewed another way, 50% of the gunshot cases were shot within between 8 and 15 hours of waking and 50% of the non-gunshot cases were assaulted within between 6 and 13 hours of waking. For 50% of controls, the time between waking and going to bed ranged from between 12 and 17 hours.

Considering the entire sample, the farthest that subjects travelled from home over their reporting periods was a median of 1 mile (IQR 0, 3). Half of the gunshot case subjects were within 1 mile, 75% were within 3 miles, and 90% were within 5 miles of their home at the time they were shot. Similar findings were seen among the non-gunshot cases, where half the subjects were within 1 mile, 75% were within 2 miles, and 90%

were within 5 miles of their home when assaulted. Among controls, half stayed within 1 mile, 75% stayed within 3 miles, and 90% stayed within 6 miles of their home over the course of their reported activities.

Dynamics in modes of transportation and places of daily activities. In Figure 1, eFigure 2, and eFigure 3, time is expressed as a 24-hour period from 4AM, which is the earliest that any subject awoke, through to 3AM the next morning. Results in Figure 1 show that controls overall (all ages) spent a considerable portion of time during 24-hour period inside their home (46%) and 23% outside. Gunshot cases overall spent 29% of the 24-hour period inside their home and 46% outside. Non-gunshot cases overall spent 27% of the 24-hour period inside their home and 39% outside.

eFigure 2 shows that younger controls (ages 10-18 years) spent more time inside their home than did older controls and spent a considerable portion of time in school between 8AM and 3PM. Relative to controls, on the days that younger individuals were shot they spent relatively little time in school and both younger and older gunshot victims spent considerably less time at home and more time outside. Younger non-gunshot cases spent a portion of time in school between 8AM and 3PM and a considerable portion of time inside another place between approximately 8AM and 7PM.

eFigure 3 shows that older controls (19-24 years old) spent a greater portion of those hours and other daytime and night hours inside work. Older gunshot cases spent little time at work and spent a considerable portion of time in a car. Between 8AM and 7PM and also later hours, older non-gunshot cases spent a considerable portion of time inside another place and an increasing portion of time outside. Older non-gunshot cases

also spent a considerable portion of time in a car and compared to controls spent less time at work.

Dynamics of exposure levels during travel across urban landscape across. Having completed the factor analysis, it is evident that the mapped layers in Figure 2 are informative not only when compared to one another visually but also by considering the results of the factor analysis which, as described above, identified that there was considerable correlation in the prevalence of environmental characteristics that were present in the locations where subjects spent time. For example, the layers reveal that areas of the landscape that were high in belonging (i.e., the extent to which residents feel that they belong and are part of their neighborhood; in the layer, red peaks represent areas with low belonging which is hypothesized to pose an assault risk) were also high in the characteristics that are represented in the layers for improve, participation, and trust and low in stress (see eTable 2, listing the question wording). Also, these five characteristics were found through factor analysis to be highly correlated and combine to represent a construct of neighbor connectedness (see eTable 3, showing the results of the factor analysis). As another example, the prevalence of African American residents and the prevalence of Hispanic residents were inversely correlated, as revealed by visual inspection of the surface layers and also in the factor analysis results.

Regression Analysis.

Environmental Exposures Experienced by Cases Over Daily Activities. As noted in the manuscript, the part 1 regression results do not account for the possibility that cases, and controls, experienced varying levels of exposure during their daily activities.

The analysis of exposure level variability with respect to the six factors (eFigure 4) gives insight into this possibility, and reveals variability in the extent to which subjects were exposed to characteristics of the environment, as measured by the six environmental factors, over the course of their daily activities. For each subject, we determined the highest level of exposure that was experienced and the lowest level of exposure that was experienced to each factor during daily activities, and report those differences here as measured in standard deviation units. Each histogram shows the proportion of gunshot cases, non-gunshot cases, or control subjects who experienced a difference between a minimum of 0 to a maximum of 5 standard deviation units when comparing the highest level of exposure that they experienced to the lowest level of exposure that they experienced. The considerable spread horizontally to the right side of each histogram reveals that a considerable proportion of subjects experienced a wide range of exposure levels. For example, for 38% of gunshot cases, 37% of non-gunshot cases, and 40% of controls, the highest level of exposure to neighbor connectedness that was experienced was one or more standard deviation units higher than the lowest level of exposure to neighbor connectedness that was experienced.

Other results (eFigure 5) provide similar information on the extent to which subjects were exposed to characteristics of the environment as measured by the four environmental variables that were not measured as part of the six environmental factors. The histograms reveal that a considerable proportion of subjects experienced a wide range of levels of exposures to the characteristics of the environment measured by these four variables. For example, for 64% of gunshot cases, 62% of non-gunshot cases, and 64% of controls, the highest level of exposure to recreation centers that was experienced

was one or more standard deviation units higher than the lowest level of exposure to recreation centers that was experienced. To see this variability emerge from the data is profound, being our first evidence that the extent to which adolescents and young men are exposed to risk and protective factors in the environment varies widely over the course of their daily activities. As reported next, the case-crossover analysis let us estimate whether changes in exposure levels experienced during daily activities seem to abruptly trigger the event of being assaulted.[23]

Also, we found moderate and large positive correlations when conducting the within-subject comparison of levels of exposure that were present in the locations where subjects lived and the mean levels of exposure experienced during daily activities (eTable 5). Hence, whereas a large proportion of gunshot cases, non-gunshot cases, and control experienced a wide range of exposures as they went about daily activities, subjects who lived in a high exposure area experienced levels of exposure that were generally higher than those experienced by subjects who resided in an area with lower exposure.

eAPPENDIX 4

DISCUSSION

In the manuscript we mentioned that the induction periods may be longer than the 10 minute period that we investigated. An effect from consuming alcohol may be a short as 10 minutes if the context of the drinking event is what triggers the risk for assault. But the effect period[23] – the period of elevated risk that occurs after the exposure has taken place – may occur more than 10 minutes after consuming alcohol if the reduced inhibition occurring after alcohol is metabolized is what triggers the risk of assault. To investigate, Maclure originally proposed that the induction period could be identified by expanding to sequentially into longer intervals and identifying the duration that maximizes the odds ratio.[23] Recent work indicates that a more sophisticated modeling approach may be required to avoid biased results, however.[20] Therefore, we are pursuing a separate analysis of this issue and will report it in a format longer than can be included here.