

Neighborhood Predictors of Concealed Firearm Carrying Among Children and Adolescents

Results From the Project on Human Development in Chicago Neighborhoods

Beth E. Molnar, ScD; Matthew J. Miller, MD, MPH, ScD; Deborah Azrael, PhD; Stephen L. Buka, ScD

Background: Previous studies of concealed firearm carrying among children and adolescents have focused on individual risk factors.

Objective: To identify features of neighborhoods associated with concealed firearm carrying among a representative sample of youth from Chicago, Ill.

Design: Cross-sectional analysis of individual- and neighborhood-level data collected by the Project on Human Development in Chicago Neighborhoods.

Setting: Families and neighborhoods in Chicago.

Participants: Population-based sample of 1842 multiethnic youth aged 9 to 19 years and the 218 neighborhoods in which they resided.

Main Outcome Measure: Whether youth had ever carried a concealed firearm.

Results: Lifetime estimates for concealed firearm carrying were 4.9% for males and 1.1% for females. We found

that youth in safer and less disordered neighborhoods were less likely than youth in unsafe and more disordered neighborhoods to carry concealed firearms. Specifically, multilevel nonlinear regression models identified a positive association between concealed firearm carrying and (1) community members' ratings of neighborhoods as unsafe for children; (2) neighborhood social disorder; and (3) neighborhood physical disorder. Neighborhood collective efficacy was negatively associated with concealed firearm carrying. Models controlled for neighborhood economic indicators and individual and family factors associated with the carrying of concealed firearms by youth.

Conclusions: Youth are less likely to carry concealed firearms in areas where there is less violence and increased safety. Interventions to improve neighborhood conditions such as increasing safety, improving collective efficacy, and reducing social and physical disorder may be efficacious in preventing firearm use and its associated injuries and death among youth.

Arch Pediatr Adolesc Med. 2004;158:657-664

UNDER FEDERAL LAW, INDIVIDUALS younger than 18 years are prohibited from owning handguns and in most states from carrying concealed weapons.¹ Nonetheless, data from the Youth Risk Behavior Survey^{2,3} (YRBS) and other studies indicate high levels of self-reported gun carrying among American youth. During the last several years, the YRBS found that of high school students in the United States, 7.6% in

about current firearm carrying.⁴ For example, the 1994-1995 National Longitudinal Study of Adolescent Health⁵ provided a national estimate of 9.3% of 7th through 12th graders having ever carried a firearm at school.

Almost all of the published literature about concealed firearm carrying by youth focuses on how individuals who carry concealed firearms differ from those who do not. In aggregate, these studies have provided a detailed picture of individual-level predictors of carrying, including male sex,⁶⁻¹⁰ minority background,¹¹ cigarette smoking,⁶ alcohol consumption,^{6,8,10,12} drug use,^{7,12-14} gang membership,¹⁵ criminal activity,⁷ fear of victimization,^{9,12,13,16,17} poor academic performance,^{6,10} fighting,^{4,8,18} lack of confidence in being able to stay out of fights,^{6,13} and exposure to violence.^{5,19,20}

For editorial comment see page 705

1995² and 5.7% in 2001³ reported having carried a firearm in the preceding 30 days. Not surprisingly, studies that ask if a child or adolescent has ever carried a firearm yield higher estimates than those that ask

From the Department of Society, Human Development, and Health (Drs Molnar and Buka), Department of Health Policy and Management (Drs Miller and Azrael), and Harvard Injury Control Research Center, Harvard School of Public Health, Boston, Mass.

Neighborhood characteristics associated with violence may play an additional and possibly synergistic role in a youth's decision to carry a firearm. Consistent with this possibility, fear of victimization^{9,12,13,16,17} in one's neighborhood or school has been offered as a primary reason why youth carry concealed firearms. In addition, behaviors associated with carrying such as drug and alcohol use,^{21,22} lower academic achievement,²³ delinquency,²⁴ and violent victimization²⁵ are known to be influenced by community factors.

Levels of social and physical disorder are 2 features of urban neighborhoods associated with fear of victimization. When strangers behave in public spaces in ways that are considered threatening, these behaviors constitute social disorder.²⁶ Examples include interactions such as drug dealing, prostitution, loitering, or public intoxication. In contrast, physical disorder describes the environmental deterioration of urban landscapes, such as abandoned properties, graffiti, and discarded drug paraphernalia and condoms. In addition to making people fearful of being victimized, observation of disorder can influence the attributions that are made about a neighborhood and may affect real estate prices, investors, and community residents' pride or willingness to actively contribute to its improvement.

Collective efficacy, on the other hand, is a neighborhood-level construct that has been linked to reduced levels and perceptions of violence. Sampson et al²⁵ defined this construct as a combination of social cohesion, represented by mutual trust and solidarity between neighbors, and informal social control, or the capacity of neighborhood residents to regulate the members of their community and reach collective goals.

Few studies to date have had the opportunity to explore youth firearm carrying within an overarching sociological framework emphasizing potential neighborhood-level determinants of individual development. Ours provides such an opportunity because questions about firearm carrying were embedded within a large multilevel study of neighborhood-level determinants of violence. To our knowledge, this study represents the first attempt to assess the independent effects of individual-, family-, and neighborhood-level characteristics on the probability that a youth has carried a concealed firearm.

METHODS

Data come from the Project on Human Development in Chicago Neighborhoods (PHDCN), a multidisciplinary study of families and neighborhoods. Study families are residents of Chicago, Ill, and are of diverse races and ethnicities, socioeconomic status, and family structures. The PHDCN includes a comprehensive community design as well as a longitudinal cohort study embedded within the community design. Data used in this study are cross-sectional and come from 4 sources: (1) wave 2 of the longitudinal cohort study; (2) systematic social observation of study neighborhoods; (3) an independent community survey of Chicago residents; and (4) 1990 US census data. A detailed description of the PHDCN's design and methods is available elsewhere.²⁷ The institutional review boards of Harvard Medical School and the Harvard School of Public Health (Boston, Mass) approved all procedures. Informed consent was obtained from both caregivers and youth prior to each interview.

SAMPLING

Sampling was accomplished in 2 stages. First, using 1990 US census data, 343 neighborhood clusters that were geographically compact as well as similar in ethnic composition, socioeconomic status, housing density, and family structure were identified and grouped into 7 strata of race and ethnic composition according to tertiles of socioeconomic level. Each neighborhood cluster contained approximately 8000 residents. Among these 21 strata were 3 empty cells; no neighborhood clusters were more than 75% Hispanic with high socioeconomic status, more than 75% white with low socioeconomic status, or of mixed Hispanic and African American race with high socioeconomic status. Eighty neighborhood clusters were chosen for intensive study from the remaining 18 cells using stratified random sampling, except for 3 cells with fewer than 5 neighborhood clusters that were sampled with certainty.

The second goal of sampling was to select families residing within each of the 80 selected neighborhood clusters to compose the longitudinal cohort study sample. Households were screened for eligible children and adolescents within 6 months of 7 target cohort ages (0 [in utero through age 6 months], 3, 6, 9, 12, 15, and 18 years). Within a selected household, all children and adolescents of eligible ages in 1994-1995 were invited to participate along with at least 1 primary caregiver for those younger than 18 years.

INDIVIDUAL-LEVEL DATA

Data used in our investigation were obtained from youth in the 9-, 12-, and 15-year-old cohorts for whom the response rate was 74%. For these cohorts, baseline assessments were conducted with 2345 youth beginning in 1995 and ending in 1997, and follow-up interviews were done with 1921 youth approximately 24 months later, beginning in 1997 and ending in 2000. The analytic sample for this investigation consisted of everyone in this follow-up group who completed a questionnaire on firearm carrying (n=1842). For the multilevel analyses (n=1751), we excluded an additional 91 youth who moved outside the city limits of Chicago between baseline and follow-up for whom we no longer had neighborhood data. Mean values of the neighborhood variables calculated for this analytic sample were the same (to the first decimal place) as those for the entire baseline sample. The analytic sample had approximately the same demographic composition as the baseline one.

NEIGHBORHOOD-LEVEL DATA

Community Survey

A random sample of adults were surveyed in 1995 to characterize residents' perceptions of Chicago neighborhoods, with oversampling done in the selected 80 neighborhood clusters. There was a 75% response rate, resulting in 8782 study participants representing all 343 neighborhood clusters. The survey focused on the social and organizational characteristics of neighborhoods, including assessments of violence and perceptions of neighborhood danger. This sample was independent of the longitudinal cohort sample of families.

Systematic Social Observation

For a description of natural social phenomena occurring in neighborhood environments, a systematic social observation study²⁸ was conducted using block-by-block videotaping and trained observers rating their observations as they were driven down city streets at approximately 5 mph. This study was conducted in 1995 and covered all 80 sampled neighborhood clusters.

ters, recording data from 23816 face blocks (the left and right sides of a street when one is in the middle of the road) for a mean of 298 per neighborhood cluster. A random sample of 15141 videotaped face blocks was selected for coding owing to budgetary constraints. Detailed information on physical conditions, housing characteristics, types of businesses, and negative social interactions was coded.

In this study, models that included measures from the systematic social observation study had a smaller sample size ($n=1606$) than those including data from the community survey because 236 participants had moved away from the 80 initial study neighborhoods before the follow-up interview. As described earlier, the 1995 community survey covered the entire city of Chicago; thus, participants who moved to other Chicago neighborhoods were able to be kept in their particular models using data from the community survey. This increased the neighborhood sample size ($n=218$).

MEASURES

Items regarding gun use were administered in the individual-level cohort study. Youth were asked (1) whether they had ever carried a concealed or hidden gun anywhere; (2) whether anyone in their home kept a gun; and (3) whether any family members had ever been shot or killed by a gun.

A composite measure of family socioeconomic status was created based on principal components analysis²⁹ of 3 variables—parental income, parental education, and parental occupational code—taking the maximum value for each if there were 2 parents in the household. A neighborhood-level index of concentrated poverty was derived from 1990 US census data for the proportion of residents who had an income lower than the poverty line, were unemployed, or were receiving public assistance.

Individual-level exposure to violence was measured by asking youths about their experiences during the past year.³⁰ Confirmatory factor analysis³¹ showed that 3 separate constructs were present. Hierarchical item response theory models³² confirmed which items fit within each construct, and 3 scales were developed: (1) victimization, (2) witnessing violence, and (3) hearing about violence. These scales showed good reliability and validity (R. T. Brennan, EdD, B.E.M., and F. Earls, MD, unpublished data, 2004). Respondents were categorized as having been victimized by violence if they reported being attacked with a weapon, beaten up, chased, shot at, or seriously threatened. If they had witnessed these same acts perpetrated on somebody else and/or saw someone being shot or killed, they were categorized as having witnessed violence. They were categorized as having heard about violence if they reported hearing about someone they knew being sexually assaulted, shot, or killed. Because the vast majority of the youth who carried concealed firearms were in the highest quartile of exposure to violence, dichotomous variables were also constructed for which 1 represented the highest quartile and 0 constituted the remainder of the sample.

Subjects were also administered a reduced version of the Youth Self-Report³³ externalizing behavior problems scale, which assesses delinquent and aggressive behaviors in the past 6 months. The scale scores are a sum of 21 items for which 0=not true, 1=somewhat true, and 2=very true. To lessen response burden in the follow-up interviews, a reduced version of the Youth Self-Report scale was created with factor analysis using the sample's full-scale data from baseline interviews. Factor loadings for individual items contributing to the various subscales were examined, and items that loaded least strongly on the scale were dropped. The Cronbach α was calculated before and after dropping these items to ensure that the reliability of the scale measurement was not dramatically reduced. This was based both on published values for the Youth Self-Report scale normative

samples³³ and on the baseline results. The reduced instrument included 8 of 13 items for the delinquent behavior subscale and 13 of 20 items for the aggressive behavior subscale.

Neighborhood conditions related to fear of victimization were measured on 4 scales with established psychometric properties. Individual items in each of the scales are listed in **Table 1**. The unsafe-to-play scale reflects residents' perceptions of the safety of neighborhood clusters based on the 1995 community survey. Collective efficacy, a summary measure of informal social control and social cohesion, was also derived from the community survey.²⁵ Each scale was formed by finding the mean for the item responses. Although most respondents in the community survey answered all of the items, anyone responding to at least 1 item on a scale provided data for the analysis. Using an unconditional 3-level hierarchical linear item-response model that took into account the number and difficulty of the answered items, a person-specific standard error was calculated and was used to adjust for missing responses.²⁵ Scales of social disorder and physical disorder were derived from the systematic social observation study; descriptions of the methods and psychometric properties of these scales have been published previously.^{26,34} Ranges of values for each scale are presented in Table 1. Prior to using these scales in the models described as follows, they were all standardized to have a mean of 0 and an SD of 1.

STATISTICAL ANALYSES

For variables that were categorical, the χ^2 test of proportions was used to assess bivariate relationships between risk factors and the carrying of concealed weapons. Spearman correlation coefficients were used to test for bivariate relationships between carrying firearms and risk factors that were continuous, including the 4 neighborhood-level scales in the study. Spearman correlation coefficients were chosen because the dichotomous outcome variable is not normally distributed, requiring a nonparametric test.

Because of the multilevel design, hierarchical nonlinear modeling³⁵ was used to estimate the relationship between individual- and neighborhood-level independent variables and youth gun carrying. The outcome was dichotomous, so the analysis involved a standard hierarchical linear model with the introduction of special weighting to linearize the outcome at level 1. After convergence, the weights were recalculated. This method resembles logistic regression, but by using multilevel methods to account for clustering by neighborhoods, the result is a proper estimation of standard errors. It also makes it possible to estimate contextual factors that may influence behavior independent of individual characteristics. Datasets were prepared for analysis using SAS version 8.0 statistical software (SAS Institute Inc, Cary, NC) and were analyzed with the statistical program HLM 5.³⁵

The goal of the data analysis was to estimate the magnitude of the association between 4 central neighborhood-level constructs and youth firearm carrying, controlling for established individual- and family-level risk factors. Initial models included the neighborhood-level constructs, a fixed set of individual-level variables (sex, age, race and ethnicity, and family socioeconomic status), and neighborhood-level concentrated poverty. Theoretically, we considered the 4 neighborhood-level constructs to measure distinct but overlapping aspects of the environment. Because of high correlations between them, they were not able to be modeled simultaneously. Instead, the models that contained multilevel potential confounders were used 4 times with each of the primary neighborhood exposures added one at a time. Finally, individual-level risk factors previously identified in the literature were added to each model: whether the youth knew that a gun was kept at home, whether

Table 1. Summary of Items Included in 4 Scales at the Neighborhood Level Related to a Resident's Fear of Victimization as Measured by the PHDCN*

	Unsafe to Play	Collective Efficacy	Social Disorder	Physical Disorder
	How strongly do you agree or disagree that:	Informal social control: How likely it is that neighbors could be counted on to intervene if:	Presence/absence:	Presence/absence:
1	You can count on adults in this neighborhood to watch out that children are safe and don't get into trouble (reverse coded)?	Children were skipping school and hanging out on street corners?	Adults loitering or congregating	Tagging graffiti
2	Children around here have no place to play but the street?	Children were spray-painting graffiti?	Alcohol drinking in public	Grffiti painted over
3	Equipment and buildings in the park or playground nearby are well kept (reverse coded)?	A child was showing disrespect to an adult?	Peer groups with gang indicators	Gang graffiti
4	Park or playground nearby is safe during the day (reverse code)?	A fight occurred or someone was being beaten/threatened?	Public intoxication	Political graffiti
5	Park or playground nearby is safe at night (reverse coded)?	Local fire station was to be closed by the city because of budget cuts?	Adults fighting or arguing in hostile way	Cigarettes/cigars on the street
		Social cohesion: How strongly do you agree or disagree that:		
6	NA	Neighbors are willing to help each other?	People selling drugs	Empty beer bottles
7	NA	Neighborhood is close knit?	Prostitution	Abandoned cars
8	NA	People can be trusted?	NA	Condoms
9	NA	People don't generally get along with each other (reverse coded)?	NA	Needles
10	NA	People share the same values?	NA	Syringes
Range of Values Across Neighborhood Clusters Before Standardization				
	2.24 to 4.21	5.46 to 9.32	-9.35 to -5.16	-4.11 to -0.99
Reliability to Distinguish Between Neighborhood Clusters				
	0.87	0.80 for neighborhood clusters with 20 raters; 0.91 for neighborhood clusters with 50 or more raters	0.84	0.98

Abbreviations: NA, not applicable; PHDCN, Project on Human Development in Chicago Neighborhoods.

*The unsafe-to-play and collective efficacy scales were based on data from the 1995 community survey; the social disorder and physical disorder scales were based on data from 1995 systematic social observation. The unsafe-to-play scale was a 5-point Likert-type scale with answers ranging from "strongly disagree" to "strongly agree." The collective efficacy scale was also a 5-point Likert-type scale with answers ranging from "very likely" to "very unlikely" and "strongly disagree" to "strongly agree." The social disorder and physical disorder scales were "yes/no" scales.

a family member had been shot with a gun, whether the youth had high exposure to violence in the past year (either witnessing violence, being victimized, or hearing about others being victimized), and whether he or she had committed other acts of delinquency and/or aggression the past 6 months.

RESULTS

Fifty-six youth (3%) indicated that they had carried a concealed firearm. In the bivariate analyses in **Table 2**, whereas only half (50%) of the sample were male, they represented 82% of those carrying a concealed firearm. More firearms were carried by older youth, with 71% of the firearm carriers aged 16 to 19 years. There were no significant differences in concealed firearm carrying by race or ethnicity or between families of different socioeconomic status.

Although 10% of respondents reported living in a household with a firearm, they accounted for 19% of those who carried a firearm themselves. One third (32%) of respondents reported that they had a family member who had been shot with a gun, and these accounted for 76% of participants who carried concealed firearms.

Of the 56 youth who reported having carried a concealed gun, most had been exposed to high levels of violence: 93% were in the highest quartile on the scale of

witnessing violence in the past year, 63% were in the highest quartile of having heard about violent victimization of acquaintances during the past year, and 91% were in the highest quartile reporting victimization by violence in the previous year. Similarly, most firearm carriers (63%) were in the highest quartile on the scale of delinquent and aggressive behaviors.

At the neighborhood level, there were significantly higher rates of concealed firearm carrying by youth in neighborhoods that were less safe and in those characterized by greater social disorder, physical disorder, and concentrated poverty. Youth living in neighborhoods with higher levels of collective efficacy reported less firearm carrying (Table 2). In multilevel multivariate models, all of the neighborhood characteristics included in this study were significantly associated with youth carrying concealed firearms when controlling for economic conditions at both family and neighborhood levels as well as for age, sex, and race and ethnicity.

The primary focus of this investigation was whether these neighborhood characteristics were associated with concealed firearm carrying above and beyond individual and family correlates. The final step was to include previously identified risk factors at the level of the individual. **Table 3** presents the results of models that included variables measuring whether a gun was kept in

Table 2. Distribution of Reported Carrying of Concealed Firearms by Demographics and Risk Factors Among Youth Aged 9 to 19 Years Participating in the PHDCN*

Characteristic	Ever Carried a Concealed Firearm	
	No	Yes
Sex		
M	883 (49.4)	46 (82.1)
F	903 (50.6)	10 (17.9)
Race/ethnicity		
African American	536 (30.8)	19 (34.6)
Hispanic	754 (43.3)	24 (43.6)
Other/mixed race	203 (11.7)	9 (16.4)
White	247 (14.2)	3 (5.4)
Age, y		
9-12	657 (36.8)	2 (3.6)
13-15	643 (36.0)	14 (25.0)
16-19	486 (27.2)	40 (71.4)
Family SES		
Lowest	446 (25.1)	13 (23.2)
Second quartile	438 (24.6)	20 (35.7)
Third quartile	446 (25.1)	13 (23.2)
Highest	449 (25.2)	10 (17.9)
Anybody keeps a gun in the home†		
Yes	176 (10.2)	10 (19.2)
No	1544 (89.8)	42 (80.8)
Anybody in family ever shot with a gun†		
Yes	539 (31.2)	41 (75.9)
No	1189 (68.8)	13 (24.1)
Ever witnessed violence		
None	591 (33.1)	0 (0.0)
Second quartile	388 (21.7)	1 (1.8)
Third quartile	292 (16.4)	3 (5.4)
Highest	514 (28.8)	52 (92.9)
Ever victimized by violence		
None	902 (50.5)	0 (0.0)
Second quartile	5 (0.3)	0 (0.0)
Third quartile	432 (24.2)	5 (8.9)
Highest	446 (25.0)	51 (91.1)
Ever heard about violence to others		
None	447 (25.0)	3 (5.4)
Second quartile	505 (28.3)	5 (8.9)
Third quartile	420 (23.5)	13 (23.2)
Highest	413 (23.1)	35 (62.5)
Aggressive and delinquent behaviors in past 6 mo		
Lowest number	469 (28.4)	4 (7.8)
Second quartile	376 (22.7)	4 (7.8)
Third quartile	399 (24.1)	11 (21.6)
Highest number	409 (24.7)	32 (62.8)

(continued)

the home, whether a family member had been shot with a gun, individual witnessing of violence, victimization, hearing about others' victimization by violence, and delinquency or aggression by youth. For neighborhoods rated as unsafe to play, the odds of youth carrying a concealed firearm were increased (odds ratio [OR] = 5.8; 95% confidence interval [CI], 1.4-24.5); for collective efficacy, the odds were decreased (OR=0.3; 95% CI, 0.2-0.7); for social disorder, the odds were increased (OR=1.9; 95% CI, 1.2-3.2); and for physical disorder, the odds were increased (OR=2.3; 95% CI, 1.2-4.2). Given that all of the scales were standardized prior to analysis to have a mean of 0 and an SD of 1, these findings can be inter-

Table 2. Distribution of Reported Carrying of Concealed Firearms by Demographics and Risk Factors Among Youth Aged 9 to 19 Years Participating in the PHDCN* (cont)

Characteristic	Ever Carried a Concealed Firearm	
	No	Yes
Neighborhood unsafe for children to play		
Least unsafe	441 (26.0)	6 (11.5)
Second quartile	415 (24.4)	12 (23.1)
Third quartile	420 (24.7)	11 (21.1)
Most unsafe	423 (24.9)	23 (44.2)
Social disorder of neighborhood		
Least disorder	369 (25.2)	4 (9.5)
Second quartile	374 (25.6)	10 (23.8)
Third quartile	358 (24.4)	13 (30.9)
Most disorder	363 (24.8)	15 (35.7)
Physical disorder of neighborhood		
Least disorder	371 (25.3)	5 (11.9)
Second quartile	367 (25.1)	8 (19.1)
Third quartile	370 (25.3)	13 (30.9)
Most disorder	356 (24.3)	16 (38.1)
Collective efficacy of neighborhood		
Least collective efficacy	420 (24.7)	17 (32.7)
Second quartile	420 (24.7)	17 (32.7)
Third quartile	428 (25.2)	10 (19.2)
Most collective efficacy	431 (25.4)	8 (15.4)
Neighborhood disadvantage		
Least disadvantaged	434 (25.5)	12 (23.1)
Second quartile	426 (25.1)	9 (17.3)
Third quartile	407 (24.0)	14 (26.9)
Most disadvantaged	432 (25.4)	17 (32.7)

Abbreviations: PHDCN, Project on Human Development in Chicago Neighborhoods; SES, socioeconomic status.

*Data are presented as number (percentage). The sample size was 1842. We used the χ^2 test of proportions to test for differences between categorical variables and concealed firearm carrying; Spearman correlation coefficients were calculated to test for differences between continuous measures and concealed firearm carrying. Statistically significant differences at $P < .05$ are in bold.

†An additional 54 respondents, including 1 who carried a gun, said that they did not know if a gun was kept in the house or if a family member had been shot.

preted as the odds of gun carrying associated with a 1-SD increase in each neighborhood measure. There were no significant changes in either the magnitude or direction of the odds of youth carrying concealed firearms associated with neighborhood characteristics after individual-level risk factors were included.

COMMENT

Consistent with the idea that social and organizational characteristics of neighborhoods explain further variations than those accounted for by aggregated characteristics of individuals and families,³⁶ we found that neighborhood characteristics likely to increase fear of victimization predicted concealed firearm carrying among Chicago youth. Specifically, carrying of concealed firearms was positively related to both a neighborhood's level of social and physical disorder and the scarcity of safe places for children to play. These neighborhood-level associations held after controlling for individual-level and family characteristics of respondents such as sex, age, ex-

Table 3. Multilevel, Multivariate Associations Between Neighborhood Factors (Controlling for Individual and Family Factors) and Carrying of Concealed Firearms by Youth Aged 9 to 19 years Participating in the PHDCN*

	Firearm Carrying				
	Null Model	Model 1	Model 2	Model 3	Model 4
Individual/family-level factors					
Female	0.2 (0.1-0.5)	0.3 (0.1-0.6)	0.2 (0.1-0.6)	0.2 (0.1-0.5)	0.2 (0.1-0.5)
Age	1.4 (1.2-1.7)	1.4 (1.2-1.7)	1.5 (1.2-1.8)	1.5 (1.2-1.9)	1.5 (1.2-1.8)
Family SES	0.8 (0.6-1.2)	0.9 (0.6-1.2)	0.9 (0.6-1.3)	0.9 (0.7-1.4)	0.9 (0.6-1.3)
Delinquency/aggressive behavior	1.1 (1.0-1.1)	1.1 (1.0-1.1)	1.1 (1.0-1.1)	1.1 (1.0-1.2)	1.1 (1.0-1.1)
Race/ethnicity					
African American	0.4 (0.1-1.0)	0.5 (0.2-1.3)	0.4 (0.1-1.2)	0.4 (0.1-1.4)	0.5 (0.2-1.4)
Other/mixed race	0.8 (0.3-2.1)	1.0 (0.4-2.9)	0.9 (0.3-2.7)	0.8 (0.3-2.4)	0.8 (0.3-2.2)
White	0.3 (0.0-2.1)	0.5 (0.1-3.8)	0.4 (0.1-3.0)	0.1 (0.0-0.8)	0.2 (0.0-0.9)
Hispanic	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)
Gun kept at home	2.7 (1.2-6.2)	3.0 (1.3-6.7)	3.0 (1.3-7.0)	3.3 (1.3-8.4)	3.6 (1.5-8.6)
Family member shot with gun	3.4 (1.7-6.9)	3.9 (1.9-8.1)	3.6 (1.7-7.7)	3.2 (1.4-7.0)	3.4 (1.6-7.4)
Witnessed violence	4.0 (1.8-9.0)	4.0 (1.8-9.1)	4.2 (1.8-10.0)	4.7 (1.5-14.6)	4.2 (1.6-11.5)
Victimized by violence	4.5 (2.4-8.6)	4.7 (2.5-8.8)	4.6 (2.3-8.9)	5.7 (2.4-13.8)	5.5 (2.5-12.0)
Heard about others being victimized by violence	1.2 (0.7-1.9)	1.1 (0.7-1.8)	1.1 (0.7-1.9)	1.2 (0.7-2.2)	1.3 (0.8-2.2)
Neighborhood-level factors†					
Concentrated poverty of neighborhood	1.2 (0.8-1.9)	0.8 (0.4-1.5)	0.8 (0.5-1.4)	0.9 (0.5-1.6)	0.9 (0.5-1.6)
Neighborhood unsafe for children to play		5.8 (1.4-24.5)			
Collective efficacy in neighborhood			0.3 (0.2-0.7)		
Social disorder in neighborhood				1.9 (1.2-3.2)	
Physical disorder in neighborhood					2.3 (1.2-4.2)

Abbreviations: PHDCN, Project on Human Development in Chicago Neighborhoods; SES, socioeconomic status.

*Data are presented as odds ratio (95% confidence interval). The sample size was 1745 total and 1606 for models 3 and 4. Unsafe-to-play, social disorder, physical disorder, and collective efficacy scales are highly intercorrelated, necessitating separate models to estimate the association between each of them and gun carrying; concentrated poverty is included in all models. Social and physical disorder were measured only in the original 80 Chicago neighborhoods under intensive study, so youth who moved beyond those 80 neighborhoods between the first and second interviews could not be included in these models. Statistically significant differences at $P < .05$ are in bold.

†Data were determined using a continuous scale; odds ratio represents the odds of gun use associated with 1 SD of change in the scale.

posure to various forms of violence, household firearm ownership, and other delinquent or aggressive behaviors and after accounting for economic disadvantages of families and neighborhoods.

Additionally, youth who lived in neighborhoods with higher levels of collective efficacy were significantly less likely to carry a concealed firearm. Youth in these neighborhoods may feel that the community provides a measure of vigilance and protection as well as a level of oversight that makes the act of carrying a firearm no longer necessary or attractive. Many of the youth who lived in neighborhoods with higher collective efficacy were still exposed to violence; the correlation between collective efficacy and witnessing violence was low at 0.11. Informal social control of children, a component of collective efficacy, was associated with reduced delinquent behavior of adolescents in Chicago in a previous study.³⁷ Perhaps the social forces and norms found in these neighborhoods protected youth from taking the extreme step of arming themselves with guns even if they were exposed to violence.

Previous studies have shown that most adults (91%) who carry concealed firearms obtain them from their home.⁶ Given that handgun ownership is illegal in Chicago,¹ youth who report guns kept at home may come from families with a greater propensity for illegal behavior. However, only 2 (4%) of 56 firearm-carrying youth in our sample reported carrying a gun from home. In con-

trast, 64% had received or borrowed their gun from friends or family, 4% had stolen or traded for the gun, 5% had acquired the gun through unspecified means, and 23% had bought the gun themselves, consistent with similar findings by other investigators.³⁸

Several individual-level risk factors previously reported to predict concealed firearm carrying among youth appear to predict carrying among Chicago youth, including male sex,^{6-8,10,11,15,16} older age,¹⁵ having a family member who has been shot,⁶ and other delinquent or aggressive behaviors.^{4,7,8,18} We found a strong association between individual exposure to violence and carrying a concealed firearm, a relationship that held whether the youth had experienced, witnessed, or heard about violence. These results are consistent with literature that found that the primary reason youth carry concealed firearms is for self-protection.^{15,38,39} Although gun carriers in our survey overwhelmingly reported that they carry guns for self-protection, some gun carrying may be by youth who are engaged in a variety of criminal and antisocial activities. We found an association between carrying a concealed firearm and individual delinquency and aggression.

In this study, 4.9% of males and 1.1% of females between the ages of 9 and 19 years reported having carried a concealed firearm. These levels are low relative to those reported elsewhere,^{4,6,13,15,40} perhaps because of low rates of gun ownership in Chicago, where handguns are illegal.¹ In the 1997 YRBS conducted in Chicago, the 30-

What This Study Adds

Efficacious interventions are necessary to reduce the carrying of firearms by adolescents, a population at high risk for gun-related injuries and death. Previous research has identified individual-level risk factors for youth carrying firearms, especially concerns regarding personal safety in their communities. However, to our knowledge, no studies have used a multilevel approach to identify processes in those communities that may increase or decrease the risk of carrying firearms. This study uses a multilevel approach to identify potentially modifiable neighborhood-level correlates of firearm carrying by adolescents. Neighborhood social disorder, physical disorder, and the rating of neighborhoods as unsafe for children to play in were each independently associated with increased firearm carrying by youth. In addition, a positive social process, collective efficacy, was found to be independently associated with decreased firearm carrying. All of these neighborhood-level correlates remained significant when individual-level risk factors were included in the models, demonstrating that reducing social and physical disorder, increasing safety, and promoting collective efficacy among neighbors have the potential to decrease the prevalence of youth carrying concealed firearms and to reduce gun-related injuries.

day prevalence rates were reported to be 2.5% among females and 11.5% among males.⁴¹ Restricting the current analysis to youth aged 14 to 18 years, the prevalence of having carried a gun was 9.3% among males and 1.8% among females. Thus, the prevalence in this study is still lower than the YRBS estimates. One possible explanation may be social desirability bias due to the differences in study methods. Carrying a concealed gun is a rare and extreme activity; the YRBS is self-administered and anonymous, whereas our study was interviewer administered in subjects' homes. Therefore, the prevalence of firearm carrying measured in this study may be an underestimate.

Our study has several limitations. These data come from Chicago, a large city that is heavily segregated and has particular laws that make handguns illegal to own. The results may not be generalizable either to other urban areas without similar gun laws or segregation or to nonurban areas. To the extent that youth who carry guns contribute to adults' perceptions of the social impoverishment of their neighborhoods, it is possible that the relationship between gun carrying and neighborhood is bidirectional (predominantly the reverse of what we describe) or not causally related. We were unable to evaluate this possibility because we used cross-sectional data and could not estimate neighborhood-level gun carrying using data from our sample, having only 56 gun carriers distributed across 218 neighborhoods. A bidirectional, causal relationship between gun carrying and neighborhood safety offers the hope that an intervention targeted at either firearm carrying or neighborhood disorder might break or at least mitigate a seemingly vicious cycle. In addition, we asked only whether youth in our survey had ever carried a gun, not how often or how recently. As a result, we are unable to determine

whether there is a relationship between the frequency of gun carrying and our neighborhood scales. Finally, we did not assess whether peers of the youths in the study carried guns, a potentially important determinant of whether a youth carries a firearm, although we did control for other delinquent and aggressive behaviors by the respondents.

Despite these limitations, an important strength of this study is the large, multilevel design that allows us to examine the association between neighborhood social processes and a rare outcome such as concealed firearm carrying among adolescents. An additional advantage is that our questions about firearm carrying and our measures of neighborhood characteristics were obtained from separate samples. Because these data on neighborhood features do not come from the youth participants themselves, they provide an independent source of information about perceived and observed levels of disorder, safety, and collective efficacy that exist across neighborhoods.

Each of these neighborhood characteristics is potentially modifiable and thus important when considering both primary and secondary prevention of youth violence. The neighborhood-level constructs identified as strongly associated with gun carrying by youth in this cohort have not previously been described and represent potential targets for public health interventions. Decreasing the degree to which a community is burdened by threatening or hostile behavior by adults, reclaiming the number of public spaces available for children to play in, and supporting adults who are willing to intervene in the lives of their community's children may positively alter the social dynamics that currently contribute to concealed firearm carrying by youth.

Accepted for publication March 4, 2004.

This study was supported by grant R49/CCR115279-05 from the Centers for Disease Control and Prevention (Atlanta, Ga) to the Harvard Injury Control Research Center. Funding for the PHDCN was provided by the John D. and Catherine T. MacArthur Foundation (Chicago, Ill), the National Institute of Mental Health (Bethesda, Md), and the National Institute of Justice (Washington, DC).

We thank Kathy McGaffigan for her assistance with data analyses, Harvard Injury Control Research Center director David Hemenway, PhD, for his guidance, and the field staff in Chicago that tirelessly collected these data. We acknowledge the roles of Jeanne Brooks-Gunn, PhD, Felton Earls, MD, Stephen Raudenbush, PhD, and Robert Sampson, PhD, the scientific directors of the PHDCN and reviewers of this manuscript. We are especially grateful to the families participating in the PHDCN who gave us their time and energy to help us better understand their lives and communities.

This article is solely the responsibility of the authors and does not represent the official views of the Centers for Disease Control and Prevention.

Correspondence: Beth E. Molnar, ScD, Department of Society, Human Development, and Health, Harvard School of Public Health, 677 Huntington Ave, Sixth floor, Boston, MA 02115 (bmolnar@hsph.harvard.edu).

REFERENCES

1. Hepburn L, Miller M, Azrael D, Hemenway D. Much ado about nothing? the effect of non-discretionary concealed weapon carrying laws on homicide. *J Trauma*. In press.
2. Kann L, Warren CW, Harris WA, et al. Youth risk behavior surveillance—United States, 1995. *MMWR CDC Surveill Summ*. 1996;45:1-84.
3. Grunbaum JA, Kann L, Kinchen SA, et al. Youth risk behavior surveillance—United States, 2001. *MMWR CDC Surveill Summ*. 2002;51:1-62.
4. Webster DW, Gainer PS, Champion HR. Weapon carrying among inner-city junior high school students: defensive behavior vs aggressive delinquency. *Am J Public Health*. 1993;83:1604-1608.
5. Kodjo CM, Auinger P, Ryan SA. Demographic, intrinsic, and extrinsic factors associated with weapon carrying at school. *Arch Pediatr Adolesc Med*. 2003;157:96-103.
6. Hemenway D, Prothrow-Stith D, Bergstein J, Ander R, Kennedy BP. Gun carrying among adolescents. *Law Contemp Probl*. 1996;59:39-54.
7. Sheley JF, Brewer VE. Possession and carrying of firearms among suburban youth. *Public Health Rep*. 1995;110:18-26.
8. Bailey SL, Flewelling RL, Rosenbaum DP. Characteristics of students who bring weapons to school. *J Adolesc Health*. 1997;20:261-270.
9. Arria AM, Wood NP, Anthony JC. Prevalence of carrying a weapon and related behaviors in urban schoolchildren, 1989 to 1993. *Arch Pediatr Adolesc Med*. 1995;149:1345-1350.
10. Orpinas PK, Basen-Engquist K, Grunbaum JA, Parcel GS. The co-morbidity of violence-related behaviors with health-risk behaviors in a population of high school students. *J Adolesc Health*. 1995;16:216-225.
11. DuRant RH, Krowchuk DP, Kreiter S, Sinal SH, Woods CR. Weapon carrying on school property among middle school students. *Arch Pediatr Adolesc Med*. 1999;153:21-26.
12. Presley CA, Meilman PW, Cashin JR. Weapon carrying and substance abuse among college students. *J Am Coll Health*. 1997;46:3-8.
13. Kingery PM, Pruitt BE, Heuberger G. A profile of rural Texas adolescents who carry handguns to school. *J Sch Health*. 1996;66:18-22.
14. Sheley JF. Drugs and guns among inner-city high school students. *J Drug Educ*. 1994;24:303-321.
15. Hayes DN, Hemenway D. Age-within-school-class and adolescent gun-carrying. *Pediatrics*. 1999;103:e64.
16. Arria AM, Borges G, Anthony JC. Fears and other suspected risk factors for carrying lethal weapons among urban youths of middle-school age. *Arch Pediatr Adolesc Med*. 1997;151:555-560.
17. Martin SL, Sadowski LS, Cotten NU, McCarragher DR. Response of African-American adolescents in North Carolina to gun carrying by school mates. *J Sch Health*. 1996;66:23-26.
18. Sosin DM, Koepsell TD, Rivara FP, Mercy JA. Fighting as a marker for multiple problem behaviors in adolescents. *J Adolesc Health*. 1995;16:209-215.
19. Bell CC, Jenkins EJ. Community violence and children on Chicago's southside. *Psychiatry*. 1993;56:46-54.
20. Martin SL, Gordon TE, Kupersmidt JB. Survey of exposure to violence among the children of migrant and seasonal farm workers. *Public Health Rep*. 1995;110:268-276.
21. Bell DC, Carlson JW, Richard AJ. The social ecology of drug use: a factor analysis of an urban environment. *Subst Use Misuse*. 1998;33:2201-2217.
22. Ennett ST, Flewelling RL, Lindrooth RC, Norton EC. School and neighborhood characteristics associated with school rates of alcohol, cigarette, and marijuana use. *J Health Soc Behav*. 1997;38:55-71.
23. Brooks-Gunn J, Duncan GJ, Klebanov PK, Sealander N. Do neighborhoods influence child and adolescent development? *Am J Sociol*. 1993;99:353-395.
24. Sampson RJ, Groves WB. Community structure and crime: testing social-disorganization theory. *Am J Sociol*. 1989;94:774-802.
25. Sampson RJ, Raudenbush SW, Earls F. Neighborhoods and violent crime: a multilevel study of collective efficacy. *Science*. 1997;277:918-924.
26. Sampson RJ, Raudenbush SW. Systematic social observation of public spaces: a new look at disorder in urban neighborhoods. *Am J Sociol*. 1999;105:603-651.
27. Earls FJ, Visher CA. *Project on Human Development in Chicago Neighborhoods: A Research Update*. Rockville, Md: National Institute of Justice; 1997. Report NCJ163603.
28. Reiss AJ. Systematic observation of natural social phenomena. In: Costner H, ed. *Sociological Methodology*. San Francisco, Calif: Jossey-Bass, Inc; 1971:3-33.
29. Duntleman GH. *Principal Components Analysis*. Newbury Park, Calif: Sage; 1989.
30. Selner-O'Hagan MB, Kindlon DJ, Buka SL, Raudenbush SW, Earls FJ. Assessing exposure to violence in urban youth. *J Child Psychol Psychiatry*. 1998;39:215-224.
31. Long JS. *Confirmatory Factor Analysis*. Newbury Park, Calif: Sage; 1983.
32. Bryk AS, Raudenbush SW. *Hierarchical Linear Models: Applications and Data Analysis Methods*. Newbury Park, Calif: Sage; 1992.
33. Achenbach TM. *Manual for the Youth Self-Report and 1991 Profile*. Burlington: University of Vermont Dept of Psychiatry; 1991.
34. Raudenbush SW, Sampson RJ. Ecometrics: toward a science of assessing ecological settings, with application to the systematic social observation of neighborhoods. *Sociol Methodol*. 1999;29:1-41.
35. Raudenbush SW, Bryk AS, Cheong YF, Congdon RT. *HLM 5 Hierarchical Linear and Nonlinear Modeling*. Lincolnwood, Ill: Scientific Software International Inc; 2000.
36. Buka SL, Brennan RT, Rich-Edwards JW, Raudenbush SW, Earls F. Neighborhood support and the birth weight of urban infants. *Am J Epidemiol*. 2003;157:1-8.
37. Sampson RJ. Collective regulation of adolescent misbehavior: validation results from eighty Chicago neighborhoods. *J Adolesc Res*. 1997;12:227-244.
38. Sheley J, Wright J. *High School Youths, Weapons, and Violence: A National Survey*. Rockville, Md: National Institute of Justice; 1998. Report NCJ172957.
39. McNabb SJ, Farley TA, Powell KE, Rolka HR, Horan JM. Correlates of gun-carrying among adolescents in south Louisiana. *Am J Prev Med*. 1996;12:96-102.
40. Simon TR, Crosby AE, Dahlberg LL. Students who carry weapons to high school: comparison with other weapon-carriers. *J Adolesc Health*. 1999;24:340-348.
41. Kann L, Kinchen SA, Williams BI, et al. Youth risk behavior surveillance—United States, 1997. *MMWR CDC Surveill Summ*. 1998;47:1-89.