Epidemiology and Prevention of Traffic Injuries to Urban Children and Adolescents

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ABSTRACT. Objectives. To describe the incidence of severe traffic injuries before and after implementation of a comprehensive, hospital-initiated injury prevention program aimed at the prevention of traffic injuries to school-aged children in an urban community.

Materials and Methods. Hospital discharge and death certificate data on severe pediatric injuries (ie, injuries resulting in hospital admission and/or death to persons age <17 years) in northern Manhattan over a 13-year period (1983–1995) were linked to census counts to compute incidence. Rate ratios with 95% CIs, both unadjusted and adjusted for annual trends, were calculated to test for a change in injury incidence after implementation of the Harlem Hospital Injury Prevention Program. This program was initiated in the fall of 1988 and continued throughout the study period. It included 1) school and community based traffic safety education implemented in classroom settings in a simulated traffic environment, Safety City, and via theatrical performances in community settings; 2) construction of new playgrounds as well as improvement of existing playgrounds and parks to provide expanded off-street play areas for children; 3) bicycle safety clinics and helmet distribution; and 4) a range of supervised recreational and artistic activities for children in the community.

Primary Results. Traffic injuries were a leading cause of severe childhood injury in this population, accounting for nearly 16% of the injuries, second only to falls (24%). During the preintervention period (1983–1988), severe traffic injuries occurred at a rate of 147.2/100 000 children <17 years per year. Slightly <2% of these injuries were fatal. Pedestrian injuries accounted for two thirds of all severe injuries before the intervention were 127.2 for pedestrian, 37.4 for bicyclist, and 25.5 for motor vehicle occupant injuries. Peak incidence of pedestrian and bicyclist injuries occurred during the summer months and afternoon hours, whereas motor vehicle occupant injuries showed little seasonal variation and were more common during evening and night-time hours. Age-specific rates showed peak incidence of pedestrian injuries among 6- to 10-year-old children, of bicyclist injuries among 9- to 15-year-old children, and of motor vehicle occupant injuries among adolescents between the ages of 12 and 16 years. The peak age for all traffic injuries combined was 15 years, an age at which nearly 3 of every 1000 children each year in this population sustained a severe traffic injury.

Among children hospitalized for traffic injuries during the preintervention period, 6.3% sustained major head trauma (including concussion with loss of consciousness for ≥1 hour, cerebral laceration and/or cerebral hemorrhage), and 36.9% sustained minor head trauma (skull fracture and/or concussion with no loss of consciousness ≥1 hour and no major head injury). The percentage of injured children with major and minor head trauma was higher among those injured in traffic than among those injured by all other means (43.2% vs 14.2%, respectively; χ² = 336; degrees of freedom = 1). The percentages of children sustaining head trauma were 45.4% of those who were injured as pedestrians, 40.2% of those who were injured as bicyclists, and 38.9% of those who were injured as motor vehicle occupants.

During the intervention period, the average incidence of traffic injuries among school aged children declined by 36% relative to the preintervention period (rate ratio: 0.64; 95% CI: 0.58, 0.72). After adjusting for annual trends in incidence, pedestrian injuries declined during the intervention period among school aged children by 45% (adjusted rate ratio: 0.55; 95% CI: 0.38, 0.79). No comparable reduction occurred in nontargeted injuries among school-aged children (adjusted rate ratio: 0.89; 95% CI: 0.72, 1.09) or in traffic injuries among younger children who were not targeted specifically by the program (adjusted rate ratio: 1.32; 95% CI: 0.57, 3.07).

Conclusion. Child traffic injuries, particularly those involving pedestrians, are a major public health problem in urban communities. Although the incidence of child pedestrian injuries is declining nationally and internationally, perhaps attributable to declines in walking, this trend may not be applicable in inner city communities such as northern Manhattan, in which walking remains a dominant mode of transportation. Community interventions involving the creation of safe and accessible play areas as well as traffic safety education and supervised activities for school-aged children may be effective in preventing traffic injuries to children in these communities. Additional controlled evaluations are needed to confirm the benefits of such interventions. Pediatrics 1999;103(6). URL: http://www.pediatrics.org/cgi/content/full/103/6/e74; adolescent, bicyclist, child, community, epidemiology,
Injuries resulting from traffic collisions are a major cause of childhood death, hospitalization, and disability throughout the world. In urban areas and particularly in economically disadvantaged communities, children are at increased risk especially for pedestrian injuries. Recent data show a reduction in the incidence of pedestrian injury in many countries, possibly attributable to a decline in walking, but this has not been shown in inner city communities in which walking remains a dominant mode of transportation. Urban factors associated with elevated rates of child pedestrian injuries include high traffic volume, frequency of walking, and paucity of off-street, outdoor play areas.

This article describes the epidemiology of severe traffic injuries to children in the urban community of northern Manhattan, New York City before and after implementation of a comprehensive injury prevention program. The program used both environmental and educational measures aimed to prevent injuries to school-aged children.

MATERIALS AND METHODS

The database for this study is the Northern Manhattan Injury Surveillance System that includes both fatal and severe nonfatal injuries occurring in a population of ~100,000 children <17 years of age. Severe, nonfatal injuries are defined as injuries resulting in hospital admission. Northern Manhattan, as defined in this study, includes an area demarcated by the 10 northernmost ZIP codes of Manhattan, New York City, and includes the neighborhoods of Inwood, Washington Heights, Central Harlem, and a portion of Riverside. In terms of sociodemographic indicators, it is an ethnically diverse and relatively disadvantaged area of the city (Table 1).

Case Ascertainment and Computation of Numerators

Data on incident cases of injury (ie, trauma, poisonings, and burns as a result of unintentional, intentional, legal, or undetermined external causes) for a 13-year period (1983–1995) have been incorporated into the Northern Manhattan Injury Surveillance System. Traffic injuries are defined in terms of ICD-9 external cause (E) codes and include injuries to pedestrians (E810–E819.7, E826.0); bicyclists (E810–E819.6, E826.1); drivers and passengers of motorcycles (E810–E819.2,3); drivers and passengers of motor vehicles other than motorcycles (E810–E819.0,1); other (E810–E819.8, E958.5, E988.5); and unspecified (E810–E819.9) traffic injuries. Railroad injuries (E800–E807.9) are not included among traffic injuries in this report.

Injuries Resulting in Hospitalization

During the period 1983 to 1990, the Northern Manhattan Injury Surveillance System incorporated injury data abstracted from hospital charts of the two major hospitals serving the area, Harlem Hospital Center and Columbia-Presbyterian Medical Center. ICD-9 external cause (E) codes as well as ZIP codes of residence were assigned based on the data abstracted. During that same period, data on injury admissions to hospitals outside the area but involving residents of northern Manhattan ZIP codes were obtained from the New York State Uniform Hospital Discharge Database. However, in 1991 the database did not include E codes routinely. Because E codes are required to identify which injuries are traffic related, we have estimated the total number of nonfatal, hospitalized, traffic injuries in northern Manhattan during 1983 to 1990 by assuming that children treated in hospitals other than the two study hospitals (and thus lacking E codes) were distributed by cause in the same way as those treated in the two study hospitals.

For the period 1991 to 1995, E-coded data on all injury hospitalizations involving children residing in northern Manhattan ZIP codes were obtained from the New York State Uniform Hospital Discharge Database.

Fatal Injuries

For the entire study period (1983–1995), E-coded data on all fatal injuries to children residing in northern Manhattan and elsewhere in New York City were obtained from New York City death certificate files and incorporated into the database. Injuries resulting in death after hospital admission were entered into the northern Manhattan database only once.

Denominator Data

US Bureau of the Census population counts for 1980 and 1990 and population estimates for 1995 were used to obtain age-specific population denominators for the entire study period. These data showed increases in the population of northern Manhattan children of 8.1% between 1980 and 1990 and of 9.5% between 1990 and 1995; these increases are consistent with vital statistics for northern Manhattan showing a steady increase during the 1980s in the number of live births and with enrollment increases in northern Manhattan public and private elementary schools (New York State Department of Education). Population counts for the intercensus years 1983 to 1989 and for the years 1991 to 1994 were obtained by assigning a straight line increase in population during the years for which census data or estimates were available. The total estimated person-years contributed by northern Manhattan children <17 years of age during the study period was 1,259,361.

Computation of Incidence Rates

Incidence rates were obtained by dividing the number of severe injuries within each category of interest by the appropriate person-years or person-months of observation and multiplying the quotient by 100,000.
The Intervention: The Harlem Hospital Injury Prevention Program (HHIPP)

HHIPP was initiated in the fall of 1988 with the goal of reducing the incidence of pediatric injuries from falls, traffic, and assaults, which are the leading causes of severe injury to children in this community. Initially intended to serve the Central Harlem Health District, this program began in 1989 to provide school-based traffic safety education to residents of both health districts of northern Manhattan, central Harlem and Washington Heights. Descriptions of the HHIPP have been published previously. Components of the program relevant to traffic injury prevention are summarized briefly here.

Intervention Aimed at the Child Pedestrian, Bicyclist, and Motor Vehicle Occupant

A model Safety City traffic education program was developed by the New York City Department of Transportation and has been in operation in northern Manhattan since September of 1989. The Safety City program serves elementary school children throughout northern Manhattan with the goal of improving both knowledge and behavior with respect to traffic safety. It provides instruction in safe street-crossing behavior to all 3rd grade students in all Harlem schools in a simulated traffic environment. The Safety City program also includes a puppet theater company that travels to all northern Manhattan elementary school classes (kindergarten through 4th grade) and to parks and community centers to provide traffic safety information relevant to children as motor vehicle occupants, bicyclists, and pedestrians. Between 1989 and 1995, 16,800 northern Manhattan elementary school children participated in the Safety City program.

Interventions Aimed at the Child Pedestrian

Between the fall of 1988 and 1995, the HHIPP built 25 new playgrounds in central Harlem parks and schools to provide off-street outdoor play areas for children in the community. During the same time period, the program prompted the New York City Department of Parks to refurbish 18 playgrounds located in northern Manhattan parks. These playgrounds have fenced perimeters intended to prevent easy entrance to the street by children at play, and many have sprinklers to deter children from playing in the streets around open fire hydrants. The program was also influential in moving existing summer outdoor programs for children from around open fire hydrants. The program was also influential in moving existing summer outdoor programs for children from closed off streets to the newly refurbished park areas.

In addition to the playground and park projects, the HHIPP initiated several supervised recreational programs for children, featuring quality adult mentoring. A total of ~1350 children from northern Manhattan participated in these programs each year between 1989 and 1995.

Interventions Aimed at the Child Bicyclist

In 1990, the HHIPP developed a bicyclist safety initiative after a survey by the American Academy of Pediatrics New York Chapter of local pediatricians and of children sampled from five community sites identified this as a priority concern. Although 80% of children surveyed owned bicycles, <8% owned bicycle helmets. The bicycle safety initiative included biannual bicycle fix-up days, short courses on bicycle safety, and distribution of bicycle helmets and pocket-sized rules of the road. Between 1991 and 1995, the program distributed 1000 bicycle helmets to children in northern Manhattan. The program was also instrumental in generating support for state bicycle helmet legislation passed in 1993 requiring bicyclists <14 years of age to wear helmets. Also in 1993, the HHIPP sponsored the founding of a local Urban Youth Bicycle Corp in which ~60 adolescents participated each year between 1993 and 1995. In addition to recreational bicycling and the bicycle fix-up days, members of the Urban Youth Bicycle Corp taught bicycle safety to school health education classes in northern Manhattan public elementary schools.

Impact of the HHIPP

To assess the impact of the HHIPP on rates of traffic injuries, the incidence of these injuries during the intervention period (1989–1995) was compared with the incidence of these injuries during the preintervention period (1983–1988). This was done crudely by computing rate ratios obtained by dividing the overall incidence (number of injuries divided by the number of person-years of observation) during the intervention period by the comparable incidence rate during the preintervention period. Also, 95% CIs were computed for these using the Taylor approximation and the statistical package Epi Info. In addition, the method of Poisson regression was used to quantify and test for changes in monthly incidence after onset of the intervention, controlling for year-to-year variability in injury incidence that was present before the intervention. The Poisson regression models were fitted using maximum quasi-likelihood estimation in the statistical package SAS.

The regression coefficient for the intervention period, , provides an estimate of the ratio of the natural log of the injury rate after intervention to that before the intervention, adjusting for the underlying annual trend. This model assumes in the absence of an intervention effect the trends would be uniform over time. The expected effect of the intervention is to decrease the level of the injury rate. Thus, if the prevention program is associated with a reduction in traffic injuries, we would expect a rate ratio, , exponentiated, <1.0. For example, a rate ratio of 0.5 would indicate a 50% reduction in incidence during the intervention period relative to the preceding period. CIs for the rate ratios were calculated by assuming asymptotic normality of the maximum quasi-likelihood estimates of the regression parameters.

RESULTS

A total of 9521 severe injuries occurred to northern Manhattan children over the 13-year period (1983–1995), and of these injuries, 1512 (15.8%) were traffic related. Traffic was the second leading cause of severe injury in this population (after falls which accounted for 24.2%, and before assault, which accounted for 10.5% of the severe injuries). Among school-aged 5- to 16-year-old children, 22.1% of all severe injuries were traffic related. Nearly two thirds of the children who were severely injured and a full three fourths of those who were killed in traffic were pedestrians. The next leading categories were bicyclists (16%), car passengers (9%), and motorcycle drivers (4%) (Table 2). A total of 245 of severe injuries from all causes were fatal, and of these 32 (13.1%) were traffic related. Most (84.3%) of the children fatally injured in traffic were not admitted to a hospital for their injuries (Table 2).

During the preintervention period (1983–1988), the overall incidence of severe traffic injury per year was 147.2/100,000 children <17 years of age, with 1.7% of these injuries being fatal (Table 3). The incidence of pediatric injuries peaked in the 6- to 10-year age range, whereas bicyclist injuries were most frequent in the 9- to 15-year age range, and motor vehicle occupant injuries were the most frequent traffic injuries in the 12- to 16-year age range (Fig 1). Overall, the peak age for traffic injuries was 15, an age at which nearly 3 of every 1000 children in this population sustained a severe traffic injury each year and the relative contributions of pedestrian, bicyclist, and motor vehicle occupant injuries were nearly balanced (Fig 1).

The rate of traffic injury was nearly three times higher in boys than in girls (rate ratio: 2.85; 95% CI: 2.54, 3.20), and this gender difference was present for each type of traffic injury across all age groups studied and during both the preintervention and intervention periods.

Among children hospitalized for traffic injuries during the preintervention period, 6.5% had sustained major head trauma (including concussion with loss of consciousness for ≥1 hour, cerebral lac-
ation and/or cerebral hemorrhage), and 36.9% had sustained minor head trauma (skull fracture and/or concussion with no loss of consciousness $\leq$ 1 hour and no major head injury). The percentage of injured children whose injury included major and minor head trauma was higher among those injured in traffic than among those injured by all other means (43.2% vs 14.2%, respectively; $\chi^2 = 336$; degrees of freedom = 1; $P < .01$). The percentages sustaining head trauma were 45.4% for those injured as pedestrians, 40.2% for those injured as bicyclists, and 38.9% for those injured as motor vehicle occupants.

There were large temporal variations in the incidence of pedestrian and bicyclist injuries with peak incidence in the afternoon and evening hours of each day and during the summer months of each year. These patterns persisted during the preintervention and intervention periods. On the other hand, motor vehicle occupant injuries were more frequent during the evening and night and did not show a strong or consistent seasonal pattern.

The annual trend during the preintervention period was one of increasing incidence of traffic injuries to school-aged children (Fig 2), which is what had prompted the development of the HHIPP focused on this age group. During the intervention period, incidence declined among school-aged children (Fig 2). This change in the annual trend resulted in a 36% unadjusted reduction in the incidence of traffic injuries to school-aged children (rate ratio comparing the incidence during the intervention period to that during the preintervention period: .64; 95% CI: .58, .72; Table 4). Comparable reductions were not seen for traffic injuries among younger children (ages 0–4 years, not targeted by the program), for nontargeted injuries among school-aged children, or for traffic fatalities involving school-aged residents of New York City excluding northern Manhattan (Table 4).

Of the three primary categories of traffic injuries examined, the largest absolute decline in terms of the number of injuries per person-years of observation occurred for pedestrian injuries to children in middle childhood (Table 2, Fig 3).

For bicyclist injuries we looked specifically for changes in the incidence of head trauma, because this was targeted by the intervention. The incidence (per 100 000 person years among school-aged children) of both major and minor head trauma associated with bicycling declined during the intervention period. The decline in incidence was 73% for major head trauma (from 1.58 to 0.43) and 52% for minor head trauma (from 14.22 to 6.80). The decline in bicyclist injury incidence not involving head trauma was 42% (from 21.59 to 12.54).

The Poisson regression analysis that estimates the change in monthly incidence rates during the inter-

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| TABLE 2. Number (%) of Severe Traffic Injuries, by Cause and Vital Status; Among Northern Manhattan Children (<17 Years), 1983–1995 |
|---------------------------------------------|------------------|------------------|-----------------|
|                                            | Nonfatal         | Fatal Hospitalized: | Total |
|                                            | Hospitalized:    |                   | N (%) |
|                                            | Yes  | No  | Yes  | No  | Yes  | No  |
| Pedestrian                                | 957  | 4   | 20   | 981 (64.9) |
| Bicycle, all                              | 248  | 0   | 0    | 248 (16.4) |
| Collision with motor vehicle              | 84   | 0   | 0    | 84   |
| Other                                     | 164  | 0   | 0    | 164  |
| Motor vehicle occupant                    | 220  | 1   | 5    | 226 (14.9) |
| Car, driver                               | 11   | 0   | 1    | 12   |
| Car, passenger                            | 136  | 1   | 3    | 140  |
| Motorcycle, driver                        | 59   | 0   | 1    | 60   |
| Motorcycle, passenger                     | 14   | 0   | 0    | 14   |
| Other traffic                             | 13   | 0   | 0    | 13   |
| Unspecified traffic                       | 42   | 0   | 2    | 44   |
| Total                                     | 1480 | 5   | 27   | 1512 |

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<tr>
<td></td>
<td>&lt;5 Years</td>
<td>Age (5–16 Years)</td>
<td></td>
</tr>
<tr>
<td>Incidence</td>
<td>40.5</td>
<td>127.2</td>
<td></td>
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<tr>
<td>Mortality</td>
<td>.6</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Incidence</td>
<td>3.9</td>
<td>37.4</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Incidence</td>
<td>11.7</td>
<td>19.3</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>.9</td>
<td>.6</td>
<td></td>
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<tr>
<td>Incidence</td>
<td>1.7</td>
<td>2.1</td>
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<tr>
<td>Mortality</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Incidence</td>
<td>51.5</td>
<td>192.2</td>
<td></td>
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<tr>
<td>Mortality</td>
<td>.6</td>
<td>3.4</td>
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vention period relative to the preintervention period after adjusting for yearly trends in incidence estimated the rate ratio to be .65 for all traffic injuries and .55 for pedestrian injuries, implying that there were reductions of 35% for all traffic injuries and 45% for pedestrian injuries among school-aged children after implementation of the prevention program that were independent of yearly variation in incidence including that observed during the preintervention period (Table 4). The adjusted rate ratios also show that comparable reductions did not occur in nontargeted injuries to school-aged children in traffic or other injuries to younger children or in traffic fatalities to school-aged children in New York City excluding northern Manhattan (Table 4).

DISCUSSION

Descriptive Epidemiology

Traffic injuries and pedestrian injuries in particular are an important and preventable cause of severe morbidity to children in northern Manhattan. The few previous studies that have described the incidence of both severe nonfatal and fatal traffic injuries to children in defined populations have reported overall incidence rates and patterns that are similar in some respects to those reported here. For example, the age pattern of child pedestrian injuries, with peak incidence in the middle childhood years, the male excess in all categories of traffic injury, and the increased incidence during afternoon hours and summer months are consistent with previous incidence studies.2,3,35,36 These patterns support the need for injury prevention efforts targeting after school hours and summer months when children are engaged in outdoor activities.

In terms of the magnitude of child traffic injury incidence, previous studies have shown large geographic variations in rates of severe injury (ie, hospitalizations and deaths) per 100 000 population per year, from ~83 in northeastern Ohio35 to >200 in a 14-community area of Massachusetts.2 The overall rate reported here of 147.2 during the preintervention period falls in the middle of that range. What is strikingly different about traffic injury incidence in northern Manhattan is that the contribution of pedestrian injuries is larger, whereas the contribution of motor vehicle occupant injuries is considerably smaller than other population-based studies have shown. For example, within the 5- to 9-year age group, incidence studies in Massachusetts2 and North Carolina3 found <20% of the severe traffic injuries to be to pedestrians, compared with 83% in northern Manhattan. The incidence of child pedestrian injuries in northern Manhattan during the 1980s was three to five times greater than the incidence of child pedestrian injuries reported in Massachusetts, North Carolina, and Ohio, whereas the incidence of motor vehicle occupant injuries in northern Manhattan was only a small fraction of the incidence of motor vehicle occupant injuries reported in previous US studies.2,3,35

The excess incidence of child pedestrian injuries in northern Manhattan is consistent with the fact that walking is an important mode of transportation in this urban community in which relatively few fami-

Fig 1. Age-specific incidence (per 100 000 per year) of severe traffic injuries to children in northern Manhattan, 1983–1988, by type of traffic injury cause.

Fig 2. Incidence (per 100 000) of severe traffic versus nontargeted injuries to children between the ages of 5 and 16 years in northern Manhattan and traffic mortality (per 100 000) in New York City excluding northern Manhattan, by year.
lies own cars (Table 1). In addition to walking, children in this community frequently use public transportation, such as the bus and subway. Because traffic injuries occurring on or involving buses cannot be distinguished from other motor vehicle injuries using ICD-9 E codes, we cannot infer the relative contribution of bus injuries from the data available for this study. Subway or rail injuries can be distinguished and, although they were not included among traffic injuries in this report, it is notable that there were only 39 severe railway injuries to children in the population during the 13-year study period. This number is small in comparison to the 981 pedestrian, 248 bicyclist, and 226 motor vehicle occupant injuries that occurred during the same period. Precise comparisons of the relative safety of different modes of transportation cannot be made without actual measures of exposure.8,36 However, if the popularity of subway travel among adults is an indication of its popularity among children in northern Manhattan (Table 1), these results would appear to suggest that the subway provides a far safer mode of travel than do the other modes used by children in the community.

Although car, motorcycle, and bicyclist injuries were much less frequent than pedestrian injuries, the rates of these injuries may be high relative to the exposure of children in northern Manhattan to travel by car, motorcycle, and bicycle. In the absence of relevant exposure data, we cannot determine this. Ideally, future monitoring of traffic injuries in the population would incorporate measures of exposure to various modes of travel.

The fact that we observed a slightly lower percentage with head trauma among injured bicyclists than among injured pedestrians may be attributable to the fact that all the pedestrian injuries resulted from motor vehicle collisions, whereas two thirds of the bicyclist injuries did not involve motor vehicle impact (Table 2). Given the severity of the consequences of traumatic brain injuries and the known benefits of bicycle helmet use,37 efforts to promote the use of helmets are clearly justified. The age distribution of bicyclist injuries, showing peak incidence at age 15, suggests that legislative efforts are needed to extend the New York State bicycle helmet law to cover children 13 years of age.

Impact of the HHIPP

The observed decline in traffic injuries after the implementation of the HHIPP is consistent with the hypothesis that the prevention program has been effective in reducing traffic injuries among children in northern Manhattan. In terms of the number of injuries prevented, the largest impact seems to have been on pedestrian injuries among children at greatest risk, in the 6- to 10-year age range. The peak incidence in this age group present before the intervention was nearly eliminated during the intervention period (Fig 3). In support of the plausibility that the HHIPP contributed to the decline in traffic injuries described here is the fact that the reduction in injury incidence was largely specific to the injuries and age group targeted by the program. Although there was a 9% reduction in the crude incidence of nontargeted injuries among school-aged children during the intervention period, this was small compared with the

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**TABLE 4.** Rate Ratios With 95% CIs, Indicating the Ratios of the Incidence During the Intervention Period (1989–1995) to That During the Preintervention Period (1983–1988) in Northern Manhattan

<table>
<thead>
<tr>
<th>Injuries targeted by the HHIPP</th>
<th>Unadjusted Rate Ratio (95% CI)</th>
<th>Adjusted* Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Manhattan, ages 5–16 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All traffic injuries</td>
<td>.64 (.58,.72)</td>
<td>.65 (.49,.86)</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>.60 (.52,.69)</td>
<td>.55 (.38,.79)</td>
</tr>
<tr>
<td>Bicyclist (all)</td>
<td>.53 (.41,.69)</td>
<td>.67 (.22,2.03)</td>
</tr>
<tr>
<td>Motor vehicle occupant</td>
<td>.76 (.57,1.01)</td>
<td>.67 (.28,1.60)</td>
</tr>
<tr>
<td>All fatal traffic injuries</td>
<td>.81 (.37,1.74)†</td>
<td></td>
</tr>
<tr>
<td>Nontargeted injuries (all injury causes except traffic, assault, gun and fall injuries)</td>
<td>.91 (.84,.99)</td>
<td>.89 (.72,1.09)</td>
</tr>
<tr>
<td>All injuries</td>
<td>.79 (.74,.84)</td>
<td>1.11 (.94,1.32)</td>
</tr>
<tr>
<td>All traffic injuries</td>
<td>.92 (.70,1.21)</td>
<td>1.32 (.57,3.07)</td>
</tr>
<tr>
<td>New York City excluding northern Manhattan, ages 5–16 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatal traffic injuries</td>
<td>.86 (.71,1.04)</td>
<td>1.03 (.62,1.72)</td>
</tr>
</tbody>
</table>

* Adjusted for annual trends using Poisson regression.
† Adjusted rate ratio could not be estimated attributable to lack of fit between observed monthly or quarterly incidence rate and Poisson regression model.
reduction observed for traffic injuries (36%), and unlike the reduction in traffic injuries, it was not significant when controlled for the trend in incidence present during the preintervention period. Another consideration in favor of the plausibility of the intervention effect is logical coherence. By substantially increasing the accessibility of attractive, off-street play areas to effectively separate children from traffic; by enhancing the opportunities for children to engage in supervised, recreational activities; and by providing relevant, hands-on traffic safety education; the logical expectation is that the HHIPP would reduce the incidence of pediatric traffic injuries in the community. A third consideration is that the observed reduction in traffic injuries is consistent with the results of several previous evaluations of child traffic injury prevention programs. For example, the reduced incidence of pedestrian injuries to 6- to 10-year-old children in this study is similar to that observed in three US cities after implementation of the Willie Whistle traffic education program. In addition, child injury prevention programs in Scandinavia that have used strategies that were similar to those used by the HHIPP, ie, trauma surveillance followed by multifaceted interventions involving a coalition of agencies, have also shown impressive reductions in the incidence of child traffic injuries.

An important advantage of the results presented here is the inclusion of preintervention and intervention periods of sufficient length to allow detection of sustained reductions in incidence following implementation of the program. However, there is one major limitation to this study that restricts our ability to rule out explanations for the decline in traffic injuries other than effectiveness of the HHIPP. This limitation is the absence of preintervention incidence rates over time in a control community. Incidence rates of severe traffic injuries per 100 000 school-aged children in New York City excluding northern Manhattan, available only for the years 1991 to 1995, show some decline (from 136.5 in 1991 to 108.0 in 1995), but less than the decline observed in northern Manhattan during the same years (from 138.2 in 1991 to 82.0 in 1995). Without information for previous years on trends in nonfatal traffic injuries for school-aged children in areas of the city other than northern Manhattan, we cannot be certain that the decline observed in the intervention community after the implementation of the HHIPP is unique to this community.

Roberts has pointed out that pedestrian injury mortality rates are declining worldwide and suggested that this is attributable not to any specific intervention but to a decline in walking. Although this theory is compelling for secular declines in pedestrian injuries in many locations, we do not think it is applicable to the situation in northern Manhattan in which walking, alone and in conjunction with the use of public transportation, continues to be a dominant mode of transportation. A comparison of census data on the means of transportation to work and on car ownership for Manhattan residents showed little change between 1980 and 1990. Moreover, we have shown that during the preintervention period, there was no evidence of a secular decline in traffic injuries in the study population; in fact, the trend was one of increasing incidence before 1989. The observed decline occurred only after the initiation of the HHIPP.

Another limitation of this study is that even if we could firmly rule out all explanations for the decline in traffic injury incidence other than program effectiveness, we would not be able to determine from the surveillance data available which specific aspects of the HHIPP were responsible for the decline. To do so would require additional data collection and analytical studies. Such studies are needed, especially when evaluating multifaceted programs to determine the optimal use of resources for additional injury prevention efforts.

Although we have observed a marked reduction in traffic injuries in northern Manhattan in association with implementation of the HHIPP, nearly one of every 1000 children in the community were severely injured in traffic during the last year of the study period. Continued and enhanced community interventions and additional strategies are clearly needed. Traffic education combined with engineering and enforcement strategies, such as diversion of heavy traffic flow away from inner city residential areas, may be required to reduce traffic injury incidence in this community additionally.

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