Chicago Pedestrian – Motor Vehicle Collisions 2001 – 2005:

Crash Factors and Spatial Analyses

Prepared for

The City of Chicago

As part of Task Order

How to Guide for Developing and Implementing a Pedestrian Safety Plan

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Introduction

The Federal Highway Administration (FHWA) recently published *How to Develop a Pedestrian Safety Action Plan*, prepared by the University of North Carolina Highway Safety Research Center (HSRC) (Zegeer, 2006). As stressed in that document, a critical early action is to collect and analyze crash data to understand the extent and characteristics of the pedestrian safety problem. Data on locations, people involved, types of crashes, severity, and other characteristics of the crashes and crash locations is needed to identify pedestrian safety deficiencies and to select the appropriate improvements.

Under the contract with FHWA, HSRC had the opportunity to assist the City of Chicago in conducting this early phase of the Chicago Pedestrian Safety Action Plan. Pedestrian-motor vehicle collision databases were developed, and preliminary analyses of the crash characteristics and spatial distributions were completed.

Over the years 2001 to 2005, an average of more than 3,700 pedestrian-motor vehicle collisions has been reported each year from Chicago to the Illinois Division of Motor Vehicles. On average, 71 pedestrians were killed and around 930 were reported seriously injured during each of these five years. Although accounting for less than 3 percent of total Chicago collisions (246,229) during the latter two years, collisions involving pedestrians accounted for 34 percent of the fatal crashes during 2004 and 2005 (120 fatal pedestrian collisions, 351 total fatal collisions).

This report describes the methods and sources of data used and developed, and summarizes roadway/environmental, and vehicle/person characteristics of pedestrian-motor vehicle collisions for the City of Chicago based on data available in State crash databases for the years 2001 to 2005. While providing a broad overview of the Chicago pedestrian collision problems that may help in area-wide crash-reduction efforts, the characteristics discussed in this report may also help to guide more location-specific analyses of the personal, behavioral, and environmental characteristics of crashes and aid in developing appropriate location-specific countermeasures. Preliminary spatial examination of the distribution of pedestrian collisions based on available geo-coded crash data is also provided. These spatial examinations pointed to some high crash areas of the City that may be targeted by more in-depth analyses. The results are followed by a brief discussion of implications of the results, including potential further analyses to identify crash problem areas, extent, and characteristics. Such understanding will in turn aid the process of identifying countermeasures and prioritizing implementations to help reduce the toll of Chicago’s pedestrian collisions.

Data and Methods

The five years of pedestrian crash data (2001 to 2005 data set) used for the current effort were acquired from several sources. Two data sets were originally acquired from the Illinois Department of Transportation (IDOT). The Highway Safety Research Center had in-house Illinois state crash files for the years 2001-2003 that had been used as part of the Highway Safety Information System (HSIS) multi-jurisdictional database project. For the current effort, the original data for 2001 to 2003 in pre-HSIS processed state was obtained. (HSIS processes data from a variety of states and jurisdictions to have similar codes for comparable fields.) Data for the years 2004 and 2005 were also provided by IDOT during the current project period. For both data sets, Chicago crashes were identified using the city-code (from the crash data) for Chicago, and pedestrian collisions were selected where any unit involved was identified as a pedestrian. (The “Collision type” code for pedestrian was not used to select pedestrian crashes since on occasion, the first collision did not involve a pedestrian and therefore this field does not capture as many pedestrian-related collisions. Another data set generated by the City of Chicago also provided 2004 crash data, but information on the pedestrian was missing for a majority of the cases and these data could not be used.)

There were significant differences in the data for the two periods (2001-2003 and 2004-2005) due to changes in the data platform, as well as changes in the crash reporting and coding of certain variables between 2003 and 2004. Furthermore, the new reporting forms were ‘phased in’ according to an IDOT representative, so changes in codes for some variables associated with the new forms occurred gradually over the latter two years of the study period. The data for both periods were obtained in three tables, crash or event level, vehicle level, and person level files. (Subsequently, IDOT released 2004-05 data in four tables as event/crash level file, vehicle file, occupants file, and “others” file that included pedestrians, but we had proceeded too far with formatting and analyses to utilize the newer data sets.)

The Chicago Metropolitan Agency for Planning (CMAP) and its predecessor MPO agency Chicago Area Transportation Study (CATS) provided "CMAP 2003 Regional Pedestrian Crash File for Northeastern Illinois" that contained geo-coded pedestrian crashes for the 7-county Chicago region (in NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet projection). These data also contained additional pedestrian and crash-related variables in attribute tables as described in the associated meta-data (description of the GIS data). From these CMAP data, crashes that occurred within the City were selected and kept for further spatial analyses. The ‘clipped’ Chicago data closely matched the number of pedestrian collisions identified from the State data for the City of Chicago. There were 3649 pedestrian crashes in the geo-coded (CMAP) data for the City in 2003. The difference of 11 fewer crashes between this number and the number identified for Chicago from the statewide (IDOT) data (3660 for 2003) is likely due to collisions that could not be geo-coded, or else were mistakenly coded in the crash data as within the city of Chicago, but when geo-coded were not actually located in the City. Meta-data for the original data source indicated that 95 percent of all of the seven-county collisions could be uniquely located or geo-coded. (The CMAP data did not contain a unique identifier [such as the crash report number/case number] that matched the case numbers in the state-derived crash files, so additional variables cannot be added to the 2003 geo-coded data and we cannot determine the exact source(s) of the difference in number.) These data were brought into the ArcGIS (9.0 originally, then 9.1) software for analyses.

In 2004, the State began geo-coding reported crashes and adding these data to the state crash files; in this first year only crashes occurring on state-maintained roadways were geo-coded. Pedestrian and crash variables for 2004 and 2005 pedestrian crashes were also brought into the Arc GIS platform for analyses. (These data have already been provided to the City of Chicago in shapefiles and attribute tables.) Since 2004 data only included geo-coded locations for about 22 percent of the crashes for that year, they were not used in the spatial analyses. (For any future analyses involving only state-maintained roadways, these data could be used, along with data from 2003 and 2005). In 2005, crashes occurring on all public roadways were geo-coded by IDOT and assigned x and y coordinates in NAD 83 West projection, and latitude longitude coordinates. (Since the 2003 data were in NAD 83 East projection, the 2005 data were re-projected to NAD 83 East so that spatial analyses combining 2003 and 2005 data could be performed.) For 2005, 3415 pedestrian crash locations were geo-coded (of 3473) as occurring within the City, for 98% matching. The numbers, therefore for the 2003 and 2005 spatial analyses are slightly lower than the numbers reported in the descriptive analyses based on the full five-year database. Codes for each of the three crash files as provided by IDOT are included in Appendix I.

Other geographic shapefiles for the City of Chicago were provided by the City, including city boundaries, geo-political ward boundaries, major street and street network centerline files, and geo-coded school locations and corresponding school characteristics, and these files were utilized in the spatial analyses.

Descriptive Analyses

For the descriptive statistics, the 2001 to 2005 combined data set was analyzed by conducting frequency by year single-variable, and cross-tabulations (summed for the five years) for a variety of two-variable combinations. The output and data analyses for this report were generated using SAS and SAS STAT software, Version 9.1 of the SAS System for the PC (Copyright © 2002-2003 SAS Institute Inc. SAS). Table results were exported to Excel® for reporting purposes. Since the data were derived from three files containing crash level data, vehicle level data, and person-level data, most single-variable tables and all cross-tabulations involving different 'unit types' were performed by in essence, establishing the crash as the basic unit by reporting data for only the first pedestrian or driver/vehicle unit. A vast majority of collisions involved a single pedestrian (18,216 of 18,689 collisions) or a single driver (18,095 of 18,689 collisions). While some data (for example, the ages of all pedestrians involved) are not examined, this method avoids the complication of doing cross-tabulations involving one crash event variable with multiple pedestrians or drivers, or of over-representing crashes in which more than one pedestrian or vehicle was involved.

Spatial Analyses

In order to examine some spatial characteristics of pedestrian collisions in Chicago, and identify high crash zones, we conducted geographic analyses for pedestrian collisions. SPSS, CrimeStat, and ArcGIS software tools were selected for various analyses. SPSS (for Windows) is a comprehensive statistical software that includes capabilities for data analysis, data management, and programming, whose basic function of producing the descriptive results of spatial analyses was employed in our study. CrimeStat is a spatial statistics program for the analysis of crime/incident locations, which was used in this study to help calculate spatial crash density estimates.   A description of CrimeStat is provided by Levine (2004). ArcGIS (desktop) provides a collection of software products that create, edit, import, map, query, analyze, and publish geographic information developed by Environmental Systems Research Institute, Inc. (ESRI). ArcMap under ArcInfo (one of the modules in ArcGIS) was utilized in this project for all spatial related analyses. More detailed descriptions of analyses are described with results in the following section.

Results

There were 18,689 collisions involving pedestrians and motor vehicles reported for all five years. Approximately 19,600 pedestrians and 19,525 drivers were involved due to multiple pedestrian or vehicle involvement in some crashes. Nearly one-third of these collisions (6105 over the five years) were indicated to involve hit and run drivers. Ninety-eight percent (18,316) of the cases indicated the first major collision type to be (striking a) pedestrian, while other codes such as striking a parked motor vehicle, angle, turning, rear-end, fixed object, and other types of collisions (where a pedestrian was evidently struck following, or as a result of the first collision), were indicated for 2 percent of the crashes altogether. (The most common other type was striking a parked motor vehicle, with 114 collisions of this type.)

The count of crashes for the five years is as shown in Figure 1. The number of reported collisions has declined over this period. The peak of 4073 collisions occurred in 2002. The average crash count for the latter two years of the time period is nearly 15% (about 600 fewer crashes per year) below that of the first two years. Estimates indicate that the City population has also declined during this interval, from 2,896,016 residents in 2000, to an estimated 2,842,518 in 2005 (U.S. Census Bureau Web site), an estimated reduction of less than 2 percent. Using the 2000 population census data (as an estimate for 2001 population and estimated 2005 projections for 2005, city-wide population based pedestrian collision (not injury) rates are estimated at about 140 per 100,000 population in 2001 and 122 per 100,000 population in 2005. Indicated pedestrian crash reductions could be due to a variety of additional factors including changes in crash reporting levels, safety improvements, less walking by residents, or possible reductions in tourism and walking by visitors to the City. In comparison, a population based pedestrian crash rate estimate for Miami-Dade County (an urban area but one encompassing more than 2000 square miles), was about 91 per 100,000 population for 2001 and about 72 per 100,000 population (based on mid-year population projections) for 2004 (after a comprehensive pedestrian safety program had been implemented for several years) (data from Zegeer et al., draft report).

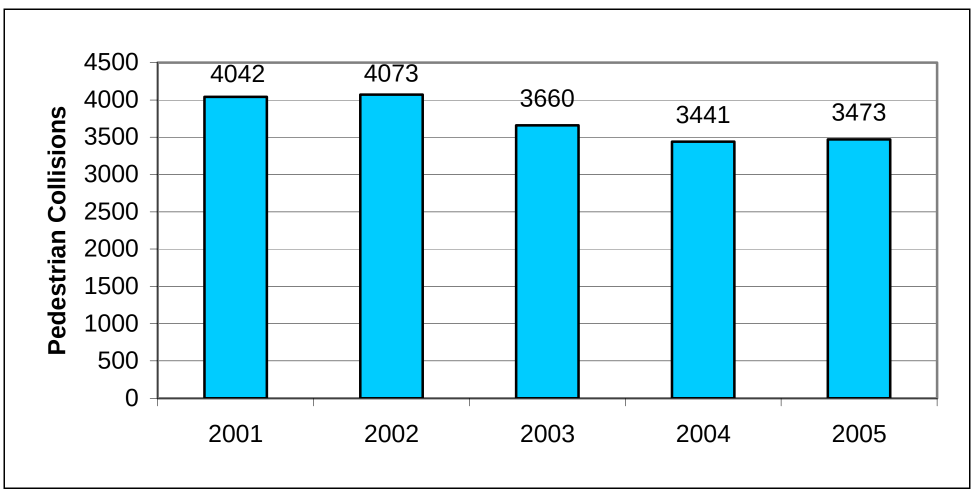

Figure 1. City of Chicago Pedestrian-motor vehicle collisions by year.

General Crash Factors

In the results that follow, counts, followed by column percents (the percent of the column total contributed by the row value) in the row beneath, are reported in the tables. Except for the first table, if a table or figure refers to pedestrians, the statistics refer only to the first pedestrian unit recorded in the crash data. Similarly, if results refer to drivers, the statistics include only the first driver unit. Once vehicle, and driver and pedestrian (person) data were merged with crash files, three cases were unmatched (so tables run on the combined data accounted for 18,686 collisions rather than the initial 18,689). The number of missing cases for that variable or for combined fields in cross-tabulations is indicated at the bottom of the tables.

Pedestrian Characteristics

Injuries Sustained
An average of 1.8 percent of pedestrians involved in collisions were killed, 97 percent reportedly sustained some level of injury, while 1 percent of those involved in reported collisions were reported to suffer no injury (Table 1). Severity indication shifted significantly beginning 2004 with a sharp decrease in the proportion noted to receive A-type (incapacitating injury) in the collision and increases in B and C-type injuries (non-incapacitating, and reported, not evident, respectively). These changes may be related to the change to new crash report forms begun in 2004 or to changes in guidance in indicating injury level. The 73 pedestrians killed in 2005 represent a fatality rate of about 2.6 per 100,000 population compared to the State of Illinois as a whole of 1.3 per 100,000 (latter statistic from NHTSA, Traffic Safety Facts: 2005 Data, Pedestrians).

Table 1. Reported Yearly Injuries Sustained by All Pedestrians in Collisions

	2001	2002	2003	2004	2005	Total
No	52	25	60	6	68	211
Injury	1.3%[1]	.6%	1.6%	0.2%	1.8%	1.1%
C Injury	901	831	670	1169	1013	4584
	21.9%	19.8%	17.9%	30.8%	27.3%	23.4%
B Injury	2039	2063	1840	1900	1911	9753
	49.5%	49.2%	49.2%	50.1%	51.4%	49.8%
A Injury	1064	1204	1101	649	651	4669
	25.8	28.7	29.4	17.1	17.5	23.9%
Fatality	66	74	73	70	73	356
	1.6%	1.8%	2%	1.8%	2%	1.8%
Total	3976	3977	3584	3441	3473	19573
	21.6%[2]	21.6%	19.4%	18.7%	18.8%	100%

[1] Column percent in this and all subsequent tables.
[2] Row percent in this and all subsequent tables.

Age of Pedestrians
Among those involved in collisions with motor vehicles, children up to age 15 comprise nearly 28 percent (percentages compiled from Table 2; note that some age groups comprise 5 years and some 10 year spans). Crash-involvement starts declining with increasing age beginning approximately with the 51 to 60-year age group. Those aged 71 and above, have accounted for less than 5 percent of pedestrian collisions over this time period. Both the numbers and proportions of those in the youngest two age groups have declined over the five years. The trend is somewhat less evident among those 11 to 15 years of age.

Table 2. Age of Pedestrians[1] Involved in Collisions with Motor Vehicles by Year

Pedestrian Age	2001	2002	2003	2004	2005	Total
< 6	196	182	186	146	109	819
	5.2%	4.8%	5.4%	4.5%	3.4%	4.7%
6 to 10	539	498	407	338	280	2062
	14.2%	13.2%	11.8%	10.5%	8.8%	11.8%
11 to 15	411	427	367	354	369	1928
	10.8%	11.3%	10.7%	11%	11.6%	11.1%
16 to 20	312	333	336	288	328	1597
	8.2%	8.8%	9.8%	8.9%	10.3%	9.2%
21 to 25	279	313	281	308	282	1463
	7.4%	8.3%	8.2%	9.5%	8.8%	8.4%
26 to 30	238	290	253	263	253	1297
	6.3%	7.7%	7.4%	8.2%	7.9%	7.4%
31 to 40	592	579	484	454	408	2517
	15.6%	15.4%	14.1%	14.1%	12.8%	14.4%
41 to 50	512	492	484	474	511	2473
	13.5%	13%	14.1%	14.7%	16%	14.2%
51 to 60	330	328	324	301	339	1622
	8.7%	8.7%	9.4%	9.3%	10.6%	9.3%
61 to 70	202	164	165	153	160	844
	5.3%	4.4%	4.8%	4.7%	5.0%	4.8%
71+	180	166	151	148	157	802
	4.8%	4.4%	4.4%	4.6%	4.9%	4.6%
Total	3791	3772	3438	3227	3196	17424
	21.8%	21.6%	19.7%	18.5%	18.3%	100%

Missing = 1262

[1] The data in this table and tables below represents the age of the ‘first’ pedestrian unit recorded in the crash.

The crash-involvement trends over the five year time period varies by age with a definite downward trend for the combined ages under 16 years (Figure 2). There is a less pronounced declining trend among adults aged 31 to 40 over the five years, with crash frequency by year remaining the about the same among young adults (16 to 30), and older middle ages (41 to 60) and declining somewhat among older adults (61+). Whether these trends reflect exposure of these age groups, safety trends, or more random factors is unknown.

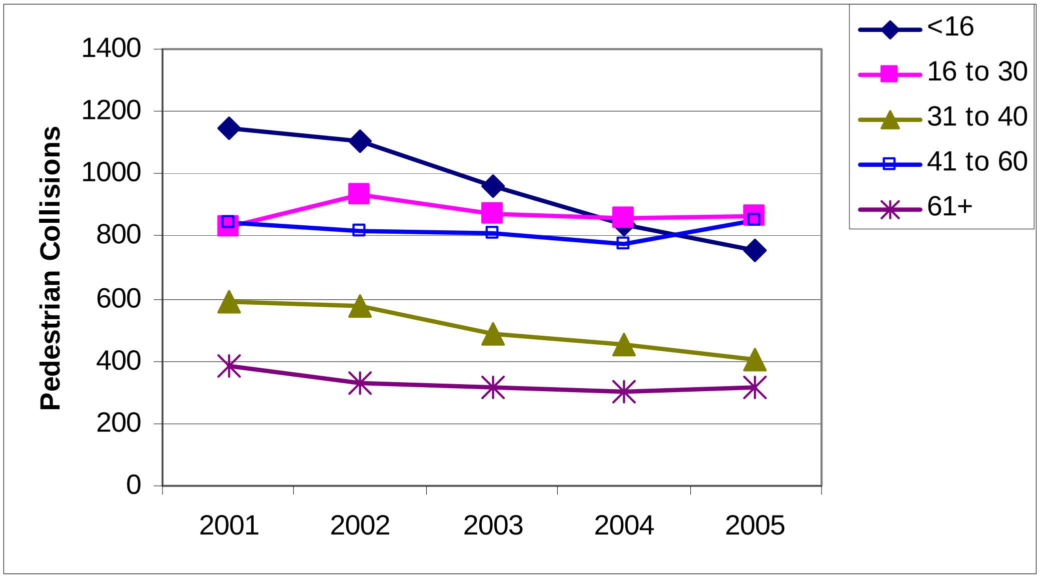

Figure 2. Yearly collision involvement by pedestrian age group

While crash involvement may decrease with increasing age, older pedestrians more often suffer fatal injuries, with more than 6 percent of struck pedestrians aged 71 and up dying as a result of a collision compared with less than 2 percent for all ages. Figure 3 illustrates injury severity percentages by combined age groups.

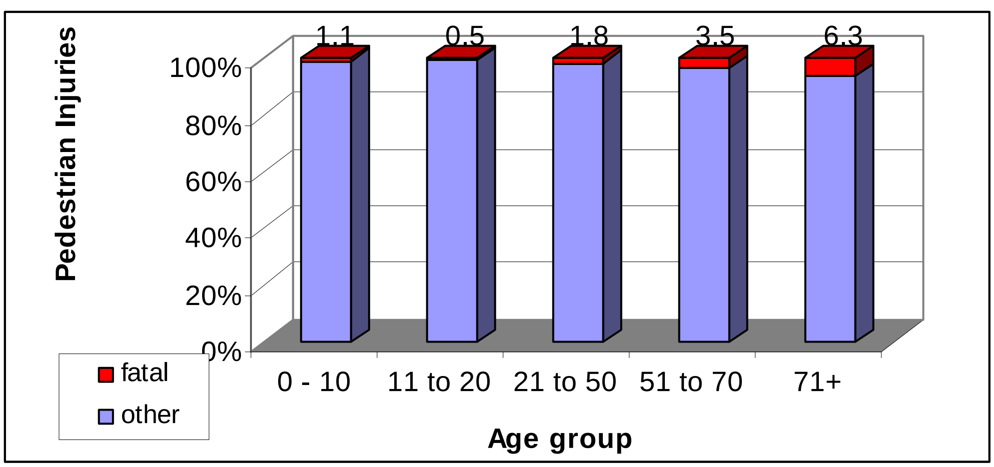

Figure 3. Pedestrian injury severity percentage by age group (2001-2005)

Sex of Pedestrians

Males represented about 60 percent of those involved in pedestrian-motor vehicle collisions at the start of this time period (based on the first pedestrian unit), but in the latest year represented less than 55% (Table 3, Figure 4). While the number of crashes among both males and females has declined over the past five years, the number of crashes involving males has decreased by 30% while that among females has declined by about 10%.

Table 3. Sex of Pedestrians involved in Collisions with Motor Vehicles by Year

Sex	2001	2002	2003	2004	2005	Total
Females	1559	1675	1518	1506	1398	7656
	39.5%	42.4%	42.6%	45.2%	45.4%	42.8%
Males	2391	2271	2042	1822	1683	10209
	60.5%	57.6%	57.4%	54.8%	54.6%	57.2%
Total	3950	3946	3560	3328	3081	17865
	22.1%	22.1%	19.9%	18.6%	17.2%	100

Missing = 824

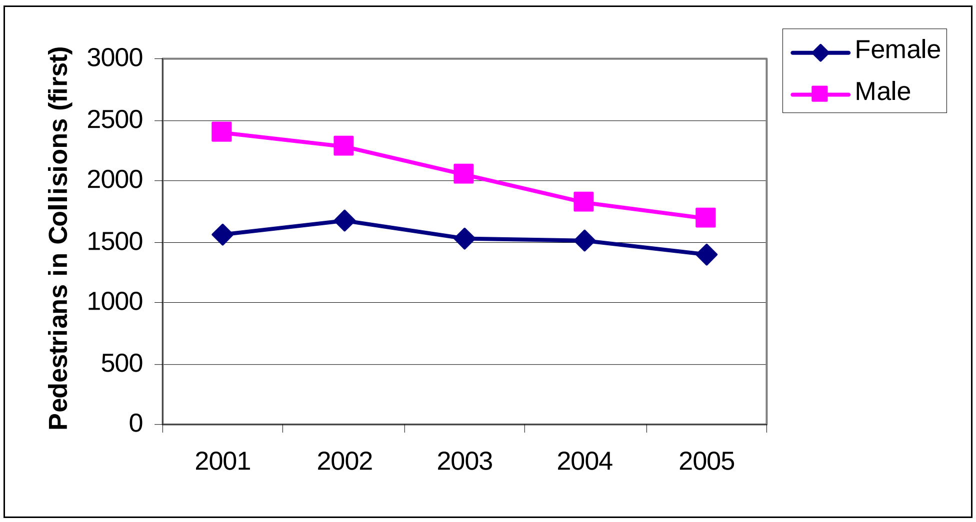

Figure 4. Yearly Collision involvement by Sex of Pedestrian

Pedestrian Apparent Physical Condition

Data regarding the pedestrian's apparent physical condition and blood alcohol concentrations were examined. A variable on the Pedestrian's Apparent Physical Condition, including indications for alcohol, drug, and other suspected impairments, was unavailable for 2001 to 2003, but data for 2004 – 2005 are included in Table 4. About 47 percent of pedestrians involved in collisions were indicated to be in a "normal" physical condition, while nearly 3 percent were reported to be impaired by alcohol. Another 2 percent were indicated as "Had been drinking" (but apparently had not obviously reached a state of impairment). About 1/3 of a percent were indicated to be impaired by other drugs, while illness, medications, and other conditions were noted for even smaller percentages. The second highest proportion, Other/unknown accounted, however, for 46 percent of the cases indicated, along with a sizable number of missing cases, making the accuracy or usefulness of the data in the remaining categories suspect. Most likely the data should be interpreted cautiously, and it is possible that officers clearly indicate drug, alcohol, or other adverse physical condition, only if it is very strongly indicated.

Table 4. Pedestrian's Apparent Physical Condition by Year.

Ped condition	2004	2005	Total
Not stated	4	185	189
	0.1%	5.3%	2.7%
Normal	1751	1463	3214
	50.9%	42.1%	46.5%
Impaired - Alcohol	112	72	184
	3.3%	2.1%	2.7%
Impaired - Drugs	15	8	23
	0.4%	0.2%	0.3%
Illness	6	1	7
	0.2%	0%	0.1%
Asleep/fainted	2	0	2
	0.1%	0%	0%
Medicated	2	1	3
	0.1%	0%	0%
Had been drinking	57	62	119
	1.7%	1.8%	1.7%
Fatigued	3	4	7
	0.1%	0.1%	0.1%
Other/Unknown	1487	1676	3163
	43.2%	48.3%	45.8%
Total	3439	3472	6911
	49.8%	50.2%	100%

Missing = 1775

Another alcohol indicator, Pedestrian Blood Alcohol Concentration (BAC) test results are also reported. Tests were offered to pedestrians in 2.9 percent of reported 2004 -05 cases where the data were not missing. Of the 82 cases, 34 (41.4 percent) had BAC > = .08, 5 (6 percent) refused to take the test, 10 (12.2 percent) had BAC <.08, and the results were unavailable/not recorded in the crash database for 33 cases (40.2 percent).

Driver Characteristics

Age of Drivers

Younger drivers accounted for larger numbers of collisions with pedestrians (based on the first driver unit) with the numbers and proportions starting to decline somewhat with the 31 to 40 year age group, and more with each subsequent 10-year group (Table 5. Note that the age ranges of the groups shown vary). How dependent these results are on population characteristics and exposure compared with other factors is unknown. There has been a declining trend, not only in the number, but also the proportion of crash involvement among the youngest drivers over this time period, especially in 2004 and 2005.

Table 5. Age of Drivers involved in Collisions with Pedestrians by Year

Driver Age	2001	2002	2003	2004	2005	Total
< 21	254	255	238	197	181	1125
	9.7%	9.6%	9.9%	8.7%	8%	9.2%
21 to 25	368	408	323	326	323	1748
	14%	15.3%	13.4%	14.4%	14.2%	14.3%
26 to 30	368	365	343	317	296	1689
	14%	13.7%	14.3%	14%	13%	13.8%
31 to 40	591	589	530	513	537	2760
	22.5%	22.1%	22.1%	22.6%	23.6%	22.6%
41 to 50	488	453	429	399	397	2166
	18.6%	17.0%	17.9%	17.6%	17.4%	17.7%
51 to 60	292	308	283	276	293	1452
	11.1%	11.6%	11.8%	12.2%	12.9%	11.9%
61 to 70	149	166	158	153	153	779
	5.7%	6.2%	6.6%	6.7%	6.7%	6.4%
71+	119	116	98	88	97	518
	4.5%	4.4%	4.1%	3.9%	4.3%	4.2%
Total	2629	2660	2402	2269	2277	12237
	21.5%	21.7%	19.6%	18.5%	18.6%	100%

Missing = 6449. Total is less than total drivers involved due to missing data and hit and run drivers for which age is undetermined.

Sex of Drivers

Males were more highly represented in collisions with pedestrians than females, accounting for nearly two-thirds of crashes (Table 6). This ratio was fairly consistent year-to-year. The Illinois Crash Facts and Statistics Report (2004 – 2005) (http://www.dot.state.il.us/travelstats/final2005crashfacts.pdf) does not report overall driver crash involvement by sex for comparison.

Table 6. Sex of Drivers involved in Pedestrian Collisions by Year.

Driver sex	2001	2002	2003	2004	2005	Total
Female	925	967	821	826	875	4414
	33.8%	35.3%	34%	33.1%	36%	34.4%
Male	1810	1774	1592	1672	1554	8402
	66.2%	64.7%	66%	66.9%	64%	65.6%
Total	2735	2741	2413	2498	2429	12816
	21.3%	21.4%	18.8%	19.5%	19%	100%

Missing = 5870. Total is less than total drivers involved due to missing data and hit and run drivers for which sex is undetermined.

Driver Apparent Physical Condition
Driver apparent physical condition data seemed consistent for the five year period, but as for pedestrian data, the second largest category, containing 35 percent of the observations, was "Other/unknown" (Table 7). Nearly two-thirds of drivers were indicated to be in "normal" condition. Alcohol impairment was suspected for only 1 percent of cases, and impairment by all other causes, combined, accounted for less than 1 percent. The large "Other/Unknown" category again perhaps reduces the usefulness of these data in understanding the contribution of driver impairments to collisions. (The suspected impairment percentages are also quite low compared to national and other cities' trends.)

Table 7. Driver Apparent Physical Condition by Year.

Driver condition	2001	2002	2003	2004	2005	Total
Normal	2553	2590	2324	2160	2201	11828
	63.2%	63.6%	63.5%	62.8%	63.4%	63.3%
Impaired -	45	42	44	31	29	191
Alcohol	1.1%	1%	1.2%	0.9%	0.8%	1.02
Impaired -	2	10	1	2	1	16
Drugs	0%	0.2%	0%	0.1%	0%	0.1%
Illness	9	2	0	5	4	20
	0.2%	0%	0%	0.2%	0.1%	0.1%
Asleep/fainted	1	3	2	0	2	8
	0%	0.1%	0%	0%	0.1%	0%
Medicated	2	1	1	1	0	5
	0%	0%	0%	0%	0	0%
Had been	17	11	13	10	7	58
drinking	0.4%	0.3%	0.4%	0.3%	0.2%	0.3%
Fatigued	5	9	3	4	3	24
	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%
Other/Unknown	1408	1405	1272	1226	1225	6535
	34.8%	34.5%	34.8%	35.6%	35.3%	35%
Total	4042	4073	3660	3439	3472	18686
	21.6%	21.8%	19.6%	18.4%	18.6%	100%

Driver BAC
Driver BAC tests were requested for 649 drivers (5 percent of cases for which data were not missing) over the five years, a number substantially greater than both the "suspected" impairment and "had been drinking" categories in the table above. About 17 percent of those tested, tested positive for BAC of .08 or greater. Another 8 percent refused the test, 45 percent had BAC < .08, and the results were unknown/not available for another 30 percent of those tested.

Environmental and Time Factors

Crash Month

More pedestrian collisions typically occur during the warmer months with increasing numbers beginning about April (Table 8). Although there are year-to-year fluctuations, the average peak in crashes occurs in June, closely followed by July.

Table 8. Yearly Pedestrian Collisions by Month

Month	2001	2002	2003	2004	2005	Total
Jan	358	305	262	265	248	1438
	8.9%	7.5%	7.2%	7.7%	7.1%	7.7%
Feb	281	314	273	275	223	1366
	7%	7.7%	7.5%	8%	6.4%	7.3%
Mar	278	324	300	275	251	1428
	6.9%	8%	8.2%	8%	7.2%	7.6%
Apr	343	368	278	271	259	1519
	8.5%	9%	7.6%	7.9%	7.5%	8.1%
May	373	394	312	307	269	1655
	9.2%	9.7%	8.5%	8.9%	7.8%	8.9%
Jun	388	429	369	326	321	1833
	9.6%	10.5%	10.1%	9.5%	9.2%	9.8%
Jul	397	360	372	337	288	1754
	9.8%	8.8%	10.2%	9.8%	8.3%	9.4%
Aug	360	358	313	251	291	1573
	8.9%	8.8%	8.6%	7.3%	8.4%	8.4%
Sep	311	335	303	306	344	1599
	7.7%	8.2%	8.3%	8.9%	9.9%	8.6%
Oct	373	299	319	274	326	1591
	9.2%	7.3%	8.7%	8%	9.4%	8.5%
Nov	317	300	272	295	289	1473
	7.8%	7.4%	7.4%	8.6%	8.3%	7.9%
Dec	263	287	287	259	364	1460
	6.5%	7%	7.8%	7.5%	10.5%	7.8%
Total	4042	4073	3660	3441	3473	18689
	21.6%	21.8%	19.6%	18.4%	18.6%	100%

December is typically one of the lower crash months, but in December of 2005 there was a particularly striking increase in the number of reported pedestrians collisions compared with the average December, resulting in the largest monthly proportion of collisions for that year (Figure 5). Weather, special events, or other factors could have contributed to this outcome illustrating the variable nature of exposure to pedestrian collisions, but also that planning for special situations could be a countermeasure to consider. In times of extreme weather, for example, more people may have to depend on walking.

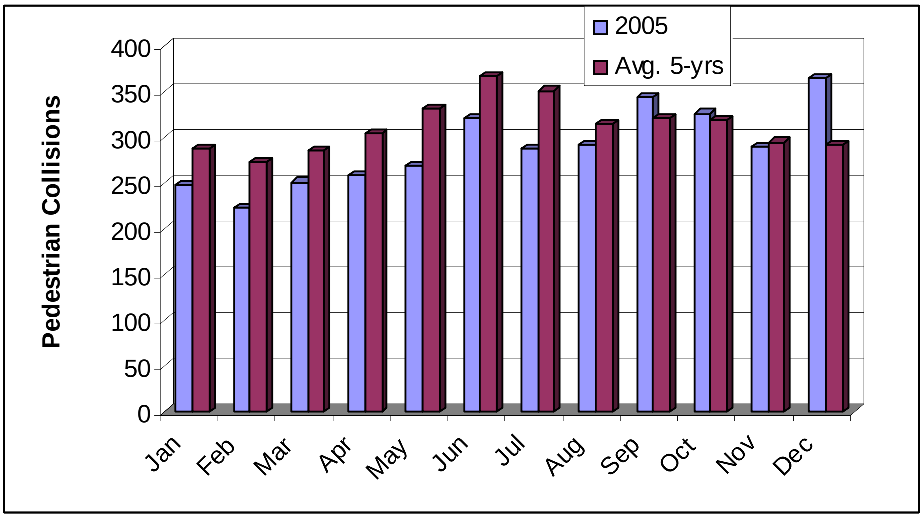

Figure 5. Comparison of monthly pedestrian collisions for 2005 and average monthly collisions for 2001 to 2005

Crash Day

Friday is the highest crash day of the week, accounting for above 16 percent of collisions and the proportion seems to have increased over the five year period (Table 9). The two weekend days of Saturday (14 percent) and, especially Sunday (11 percent) are the lowest crash days. These results could vary by time-of-year but were not examined.

Table 9. Yearly Pedestrian collisions by day of week

Day of Week	2001	2002	2003	2004	2005	Total
Friday	639	674	560	571	596	3040
	15.8%	16.6%	15.3%	16.6%	17.2%	16.3%
Saturday	574	533	509	476	479	2571
	14.2%	13.1%	13.9%	13.8%	13.8%	13.8%
Sunday	429	443	417	395	380	2064
	10.6%	10.9%	11.4%	11.5%	10.9%	11%
Monday	571	576	519	471	519	2656
	14.1%	14.1%	14.2%	13.7%	14.9%	14.2%
Tuesday	605	634	537	470	496	2742
	15%	15.6%	14.7%	13.7%	14.3%	14.7%
Wednesday	623	640	539	503	488	2793
	15.4%	15.7%	14.7%	14.6%	14%	14.9%
Thursday	601	573	579	555	515	2823
	14.9%	14.1%	15.8%	16.1%	14.8%	15.1%
Total	4042	4073	3660	3441	3473	18689
	21.6%	21.8%	19.6%	18.4%	18.6%	100%

Time of Day

The afternoon to evening peak hours account for the largest portion of crashes on a daily basis (Table 10). Nearly one-fourth of all the 18,690 pedestrian collisions occurred between the hours of 3 to 6 pm, and 45% occurred during the 6 hours from 3 to 9 pm. The afternoon peak increases sharply beginning with the 2 to 3 pm hour (Figure 6). These factors may have implications for targeting behavioral and enforcement countermeasures as well as possible engineering treatments for traffic management.

Table 10. Yearly Pedestrian Collisions by Time of Day

Time of Day	2001	2002	2003	2004	2005	Total
Midnight - 2:59 am	172 4.3%	172 4.2%	166 4.5%	184 5.4%	207 6%	901 4.8%
3 - 5:59 am	115 2.8%	87 2.1%	92 2.5%	100 2.9%	95 2.7%	489 2.6%
6 - 8:59 am	436 10.8%	408 10%	328 9%	355 10.3%	382 11%	1909 10.2%
9 -11:59 am	418 10.4%	473 11.6%	358 9.8%	403 11.7%	386 11.1%	2038 10.9%
noon - 2:59 pm	669 16.6%	715 17.6%	649 17.8%	515 15%	546 15.7%	3094 16.6%
3 - 5:59 pm	969 24%	975 24%	956 26.2%	844 24.5%	832 24%	4576 24.5%
6 - 8:59 pm	877 21.7%	828 20.4%	715 19.6%	708 20.6%	669 19.3%	3797 20.3%
9 -11:59 pm	381 9.4%	409 10.1%	390 10.7%	332 9.6%	356 10.2%	1868 10%
Total	4037 21.6%	4067 21.8%	3654 19.6%	3441 18.4%	3473 18.6%	18672 100%

Missing = 17

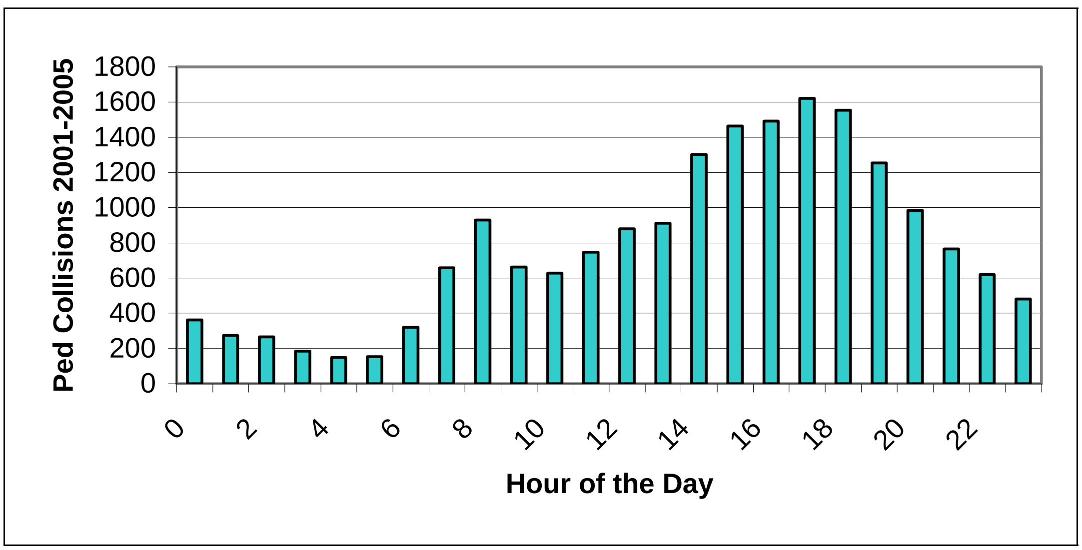

Figure 6. Average Pedestrian Collisions by Hour of Day (2001-2005)

The afternoon peak is more gradual and lower on the weekends (Figure 7) and late night crashes comprise a larger share of crashes on the weekend.

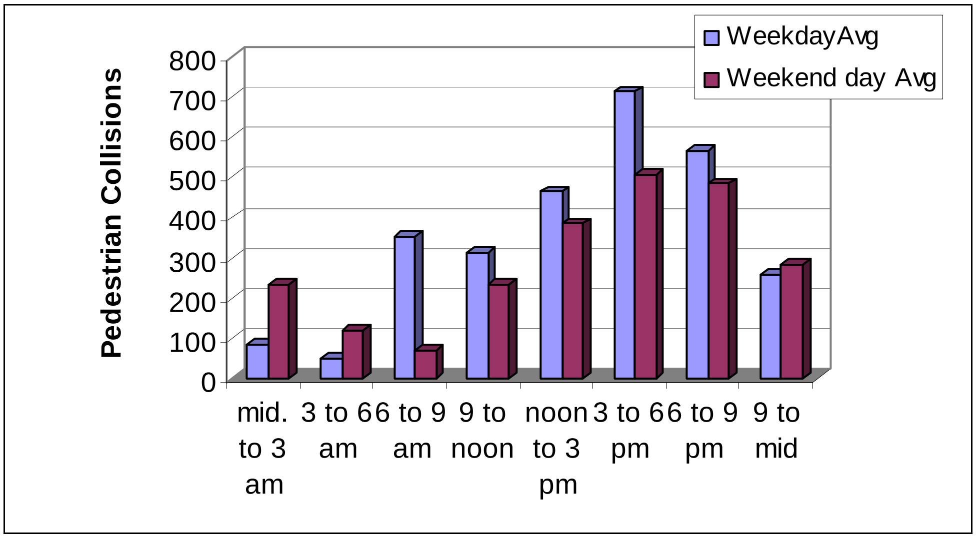

Figure 7. Comparison of weekday (M-F) versus weekend day (S,S) average pedestrian collisions (2001- 2005)

The largest share of collisions for each age group occurred during the afternoon peak period of 3 to 6 pm (Figure 8). Children up to age 15 are, however, most heavily involved in the peak afternoon (3 to 6 pm) period with 36 percent of collisions for those under 11 years occurring during this time period (compared to 22 percent over all ages). Another 30 percent occurred during the 6 to 9 pm period (compared to 15 percent over all). Other high crash periods for younger children are noon to 3 pm (17 percent) and for 11 to 15 year-olds, from 6 to 9 am (13 percent). Surprisingly, a significant portion (8 percent) of 11 to 15 year collisions occurred during the 9 pm to midnight period. Even younger children are substantially involved in night-time crashes with 5 percent of their collisions occurring during the 9 pm to midnight period. Older adults seem to be crash-involved fairly evenly throughout daytime hours, with involvement falling off by the 9 pm to midnight period. Young adults 16 to 25, and adults 26 to 40, have the highest nighttime and late night crash involvement with 12 to 13 percent of their crashes occurring from midnight to 6 am.

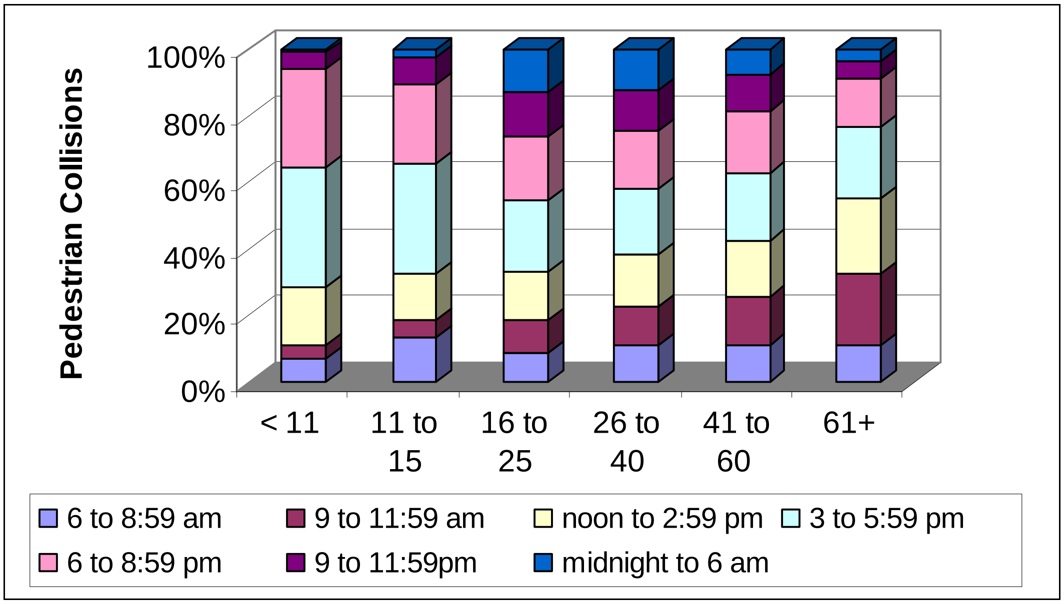

Figure 8. Pedestrian age group by time of day of collision involvement

Light Condition

A majority (nearly 64 percent, on average) of collisions have occurred during daylight conditions (Table 11). Above 30 percent of collisions were reported to have occurred during conditions of darkness on lighted (25 percent) or unlighted (5.5 percent) roadways. About 2 percent and 4 percent, respectively, have occurred at dawn and dusk. Further investigation may be needed to determine the meaning of unlighted roadway. Unlighted roadway could mean that there was no lighting on the entire segment, that a light existed but was not working at the time of the crash, that there was not a light near enough to the crash location to provide ample illumination, that there are errors in the data, or a combination of these explanations could be at work.

Although night-time (dark and dark, unlighted roadway) collisions accounted for about 30 percent of pedestrian collisions, they accounted for 54 percent of fatal pedestrian collisions (data not shown).

Table 11. Yearly Pedestrian Collisions by Light Condition

Light Condition	2001	2002	2003	2004	2005	Total
Daylight	2557	2627	2366	2124	2126	11800
	63.7%	65%	65%	62.6%	61.9%	63.7%
Dawn	165	78	30	43	61	377
	4.1%	1.9%	0.8%	1.3%	1.8%	2%
Dusk	152	160	128	133	134	707
	3.8%	4%	3.5%	3.9%	3.9%	3.8%
Dark, unlit roadway	237	221	183	199	184	1024
	5.9%	5.5%	5%	5.9%	5.4%	5.5%
Dark, lighted roadway	903	957	931	892	928	4611
	22.5%	23.7%	25.6%	26.3%	27%	24.9%
Total	4014	4043	3638	3391	3433	18519
	21.7%	21.8%	19.6%	18.3%	18.5%	100%

Missing = 170

There has been some variation over the five years, with crashes occurring under daylight and dawn conditions apparently accounting for the declines seen over the study period, and numbers of pedestrian collisions occurring under night-time and dusk conditions remaining relatively unchanged (Figure 9). It is likely that crashes under non-daylight conditions (based on the higher proportions that occur during the hours of 6 to 9 pm compared with 6 to 9 am) are over-represented, but exposure data to test this hypothesis are lacking.

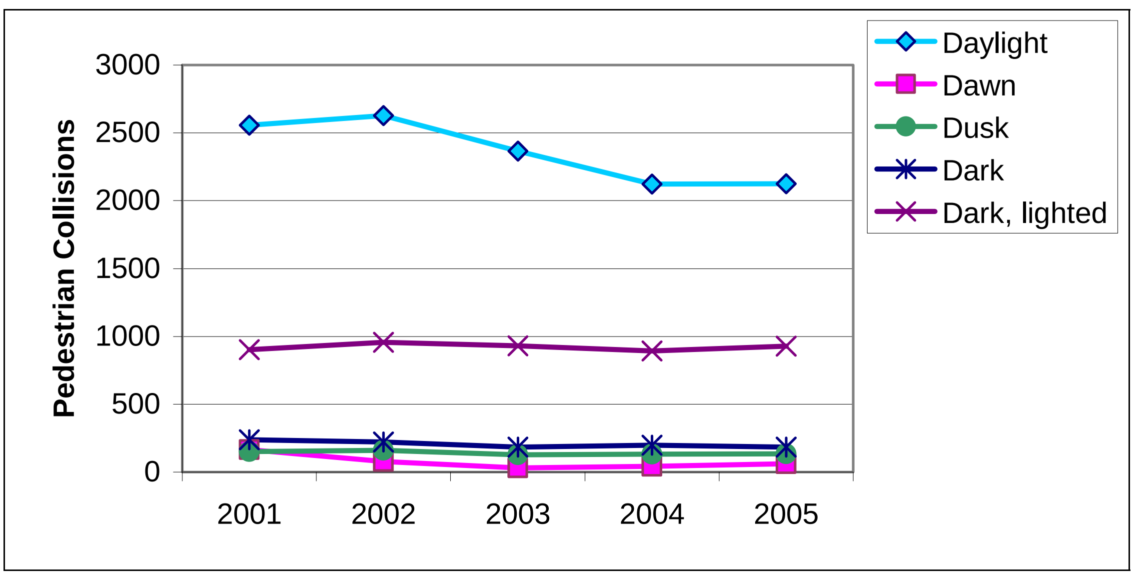

Figure 9. Pedestrian collision year-to-year trends by light condition

When pedestrians were struck during dark conditions, a majority (77 percent) of the time they were reportedly not using anything to enhance their conspicuity (Figure 10). (This variable could be highly subjective and dependent on the investigating officer's judgment.) Reflective materials, and active light sources, the most effective night-time conspicuity aids, were reportedly used only 1 percent and 4 percent of the time, respectively.

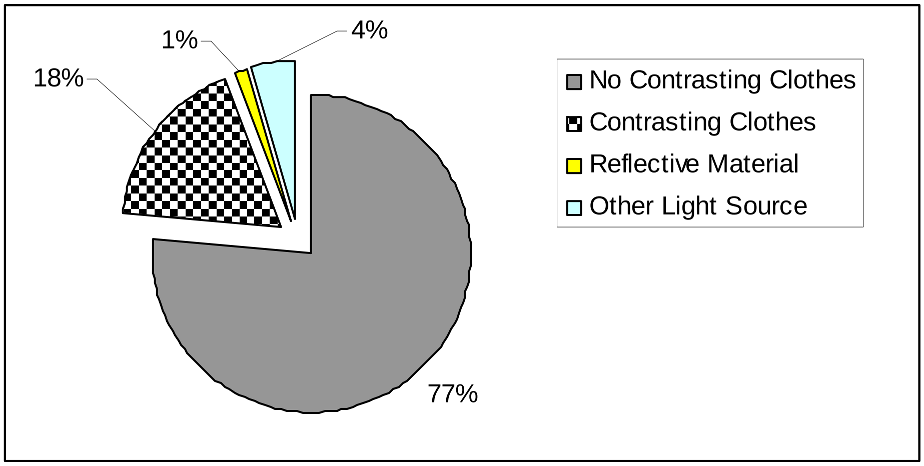

Figure 10. Pedestrian conspicuity under non-daylight conditions (2001-2005)

Most collisions (83 percent) occurred under clear weather conditions, with rainy weather accounting for nearly 12 percent, followed by snow and sleet/hail (3.4 percent combined) (Table 12). All other conditions accounted for less than 2 percent of collisions.

Table 12. Yearly Pedestrian Collisions by Weather Condition

	2001	2002	2003	2004	2005	Total
Clear	3297	3321	3008	2763	2816	15205
	83.4%	83.4%	83.9%	81.9%	83%	83.2%
Rain	510	439	385	429	376	2139
	12.9%	11%	10.7%	12.7%	11.1%	11.7%
Snow	54	142	97	110	136	539
	1.4%	3.6%	2.7%	3.3%	4%	3%
Fog/smoke/haze	37	22	30	18	16	123
	0.9%	0.6%	0.8%	0.5%	0.5%	0.7%
Sleet/hail	16	14	13	17	19	79
	0.4%	0.4%	0.4%	0.5%	0.6%	0.4%
	3	1	4	8	4	20
Severe X Wind	0.1%	0%	0.1%	0.2%	0.1%	0.1%
Other	37	45	47	27	24	180
	0.%	1.1%	1.3%	0.8%	0.7%	1%
Total	3954	3984	3584	3372	3391	18285
	21.6%	21.8%	19.6%	18.4%	18.6%	100%

Missing = 404

Roadway Characteristics
Slippery conditions, including wet pavement, snow/slush, or ice were reported for approximately 20 percent of collisions involving pedestrians, with wet roadways accounting for the largest share of these (Table 13). A majority (80 percent), however, of collisions occurred under dry conditions. Year-to-year fluctuations in both weather and road surface conditions likely represent variations in exposure to these conditions.

Table 13. Yearly Pedestrian Collisions by Road Surface Condition

	2001	2002	2003	2004	2005	Total
Dry	3102	3128	2858	2523	2622	14233
	80.5%	81%	82.1%	77.6%	79.4%	80.2%
Wet	665	621	545	605	556	2992
	17.2%	16.1%	15.7%	18.6%	16.8%	16.9%
Snow / slush	52	86	68	94	108	408
	1.4%	2.2%	2%	2.9%	3.3%	2.3
Ice	18	17	7	19	11	72
	0.5%	0.4%	0.2%	0.6%	0.3%	0.4%
Sand,mud,dirt	7	3	1	5	2	18
	0.2%	0.1%	0%	0.2%	0.1%	0.1%
Other	10	7	2	4	5	28
	0.3%	0.2%	0.1%	0.1%	0.2%	0.2%
Total	3854	3862	3481	3250	3304	17751
	21.7%	21.8%	19.6%	18.3%	18.6%	100%

Missing = 938

Road Condition
Additionally, nearly 98 percent of crashes were indicated to occur at roadway locations with no defects (data not shown). About 1 and one-quarter percent indicated a construction zone, but all other defects (worn surfaces, ruts/holes, debris in road, etc., were indicated less than one-fourth of one percent of the time).

Number Traffic Lanes
Number of lanes refers to the number of through lanes in both directions on a roadway, and does not include intermittent turn lanes. These data are supposed to be recorded for *non-intersection collisions only.* A '0' should be indicated on the crash report form for intersection crashes, indicating not applicable. There were, however, no '0's' in the original crash data obtained from the state files, and the number of missing cases does not seem high enough to incorporate all of the intersection collisions. More non-intersection pedestrian collisions (44 percent) occurred on two-lane roadways than any other type, followed by 25 percent on four-lane roads, but a surprising number (nearly 23 percent) apparently occurred on one-lane roadways according to the crash data (Table 14). There could be errors in these data including recording of number of lanes for some intersection collisions, possible recoding of '0'/intersection collisions to some other value (perhaps they were incorporated into the 1-lane data), or officers' interpretation of the field may be inaccurate. (Officers may be sometimes reporting number of lanes in each direction rather than total number of through lanes). Roads of

three lanes accounted for 3.5 percent, and five or more travel lanes accounted for less than 5 percent of reported pedestrian collisions at non-intersections for these two years (2004 and 2005). (These data were not available in the data obtained for 2001-2003).

Table 14. Yearly Pedestrian Collisions by Number of Travel Lanes

No. of lanes	2004	2005	Total
1	648	587	1235
	24%	21.3%	22.6%
2	1182	1216	2398
	43.8%	44.1%	44%
3	89	103	192
	3.3%	3.7%	3.5%
4	676	705	1381
	25.1%	25.6%	25%
5	21	22	43
	0.8%	0.8%	0.8%
6	63	75	138
	2.3%	2.7%	2.5%
7	6	4	10
	0.2%	0.2%	0.2%
8	6	13	19
	0.2%	0.5%	0.4%
9	5	25	30
	0.2%	0.9%	0.6%
10	0	3	3
	0%	0.1%	0.1%
12	2	2	4
	0.1%	0.1%	0.1%
Total	2698	2755	5453
	49.5%	50.5%	100%

Missing = 1458

Other fields indicating Roadway Functional Class and Class of Trafficway were examined, but were found to contain a number of errors (such as rural roadways coded for crashes that occurred within the City) and were too inconsistent year-to-year, including between 2004 and 2005, to provide useful information. These measures may improve as issues related to the use of new report forms and data entry procedures begun in 2004 are resolved or improve over time. If roadway attributes are available in street GIS files, they could also be added to the data in this way, or, someone familiar with Chicago's streets could perhaps make corrections to the data. (Roadway characteristics were not available in the street files used for the analyses in this report.)

Intersection-related?

More pedestrians have apparently been struck in non-intersection related crashes (56 percent) than in intersection-related ones over the past five years (Table 15). The way that intersection locations are identified, however, changed during the study period, with new crash reporting forms phased in beginning 2004. Fluctuations in 2004 and 2005 may indicate problems with the data or changes in how this field is interpreted (Figure 11). We do not, as yet, have detailed information on differences in how this variable was defined/derived during the two time periods (2001 - 2003, and 2004 – 2005). The later crash report form template states that "A crash does not have to actually occur at an intersection to be considered intersection related. For example: if 5 vehicles are lined up at a traffic signal and a rear end collision occurs at the back of the line, 75 feet from the intersection, it is intersection-related."

Table 15. Location of Pedestrian Collisions by Year

Intersection-related?[1]	2001	2002	2003	2004	2005	Total
No	2381	2188	1960	2391	1636	10556
	58.9%	53.7%	53.6%	69.5%	47.1%	56.5%
Yes	1661	1885	1700	1050	1837	8133
	41.1%	46.3%	46.4%	30.5%	52.9%	43.5%
Total	4042	4073	3660	3441	3473	18689
	21.6%	21.8%	19.6%	18.4%	18.6	100%

[1] The way intersection locations were identified changed with crash report forms phased in beginning in 2004.

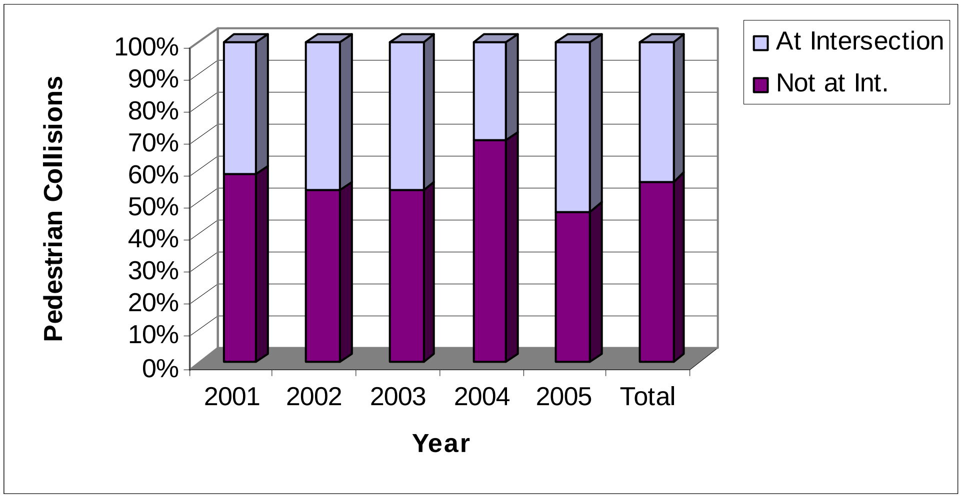

Figure 11. Yearly percents of pedestrian collisions occurring at intersection and non-intersection locations

There was, however, a slightly higher rate of fatalities reported among pedestrians struck in non-intersection related collisions (1.9 percent) compared with those struck in intersection-related collisions (1.3%, data not shown).

Type of Traffic Control

For more than half (55 percent) of the collisions, no traffic control was indicated to be present (Table 16). About 32 percent of crashes occurred at signalized locations, and nearly 10 percent occurred at stop-controlled intersections. The remainder of regulatory and warning markings and signs were present for small percentages of pedestrian collisions. Some of these types of traffic control signals, signs, and markings may not be significant in terms of being a potential pedestrian crash factor, but are apparently reported for each collision. Even a no-passing zone could, however, be significant for an individual pedestrian collision if the no-passing zone was violated and a pedestrian was crossing at the time.

For ease in understanding, a number of less frequently-involved traffic control types are combined in Figure 12. Type of traffic control would also vary by type of location (intersection versus non-intersection) but these data were not examined.

Table 16. Yearly Pedestrian Collisions by Type of Traffic Control

Traffic Control	2001	2002	2003	2004	2005	Total
No Controls	2283 57.6%	2237 56.1%	1983 55.9%	1789 53.6%	1738 51.3%	10030 55%
Stop Sign/flashing	345 8.7%	389 9.8%	361 10.2%	348 10.4%	339 10%	1782 9.8%
Traffic Signal	1166 29.4%	1226 30.8%	1105 31.2%	1098 32.9%	1184 35%	5779 31.7%
Yield	22 0.6%	8 0.2%	8 0.2%	10 0.3%	10 0.3%	58 0.3%
Police/flagman	14 0.4%	13 0.3%	12 0.3%	16 0.5%	13 0.4%	68 0.4%
RR Gate	1 0%	0 0	1 0%	2 0.1%	1 0%	5 0%
Other RR	3 0.1%	0 0	0 0	0 0	0 0	3 0%
School Zone	10 0.2%	9 0.2%	5 0.1%	3 0.1%	6 0.2%	33 0.2%
No Passing	60 1.5%	36 0.9%	12 0.3%	7 0.2%	37 1.1%	152 0.8%
Other Reg. Sign	5 0.1%	2 0%	1 0%	5 0.2%	4 0.1%	17 0.1%
Other Warning	3 0.1%	4 0.1%	2 0.1%	3 0.1%	4 0.1%	16 0.1%
Lane Use Marking	20 0.5%	26 0.6%	22 0.6%	27 0.8%	18 0.5%	113 0.6%
Other	33 0.8%	35 0.9%	34 1%	29 0.9%	33 1%	164 1%
Total	3965 21.8%	3985 21.9%	3546 19.5%	3337 18.3%	3387 18.6%	18220 100%

Missing = 469

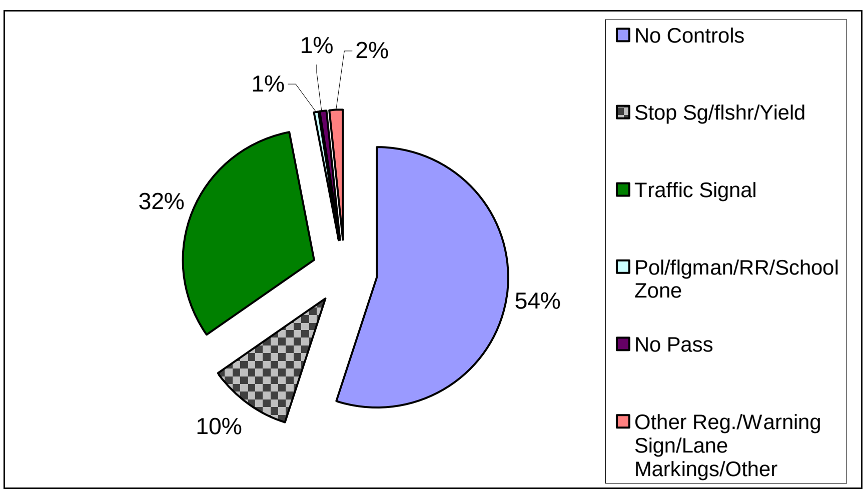

Figure 12. Pedestrian collisions by traffic control type (2001-2005)

Traffic control condition was indicated to be functioning properly about in 38 percent of total cases indicated (Table 17), or about 90% of the cases in which some type of traffic control was present (38 percent out of 7563 cases with traffic control). Missing, functioning improperly, worn markings or other condition was indicated for about 10% of the cases for which traffic control was present, with Functioning Improperly accounting for the largest share. Presence and functioning of traffic control does not necessarily mean that traffic control was an important factor in the crash, but could be an important consideration, especially for detailed site safety assessments. These data (Traffic Control Condition) would ideally be examined in connection with the types of traffic control indicated (signs, signals or markings). Additional factors such as whether pedestrian signal intervals are long enough to complete a crossing, and whether pedestrians must wait excessively long for a crossing indication (or gap in traffic) could also be examined.

Table 17. Yearly Pedestrian Collisions by Traffic Control Condition

Traffic Control Condition	2001	2002	2003	2004	2005	Total
No Controls	2326	2242	1999	1819	1777	10163
	60.6%	58.1%	57.4%	55.7%	54.1%	57.3%
Functioning Properly	1342	1451	1322	1307	1368	6790
	35%	37.6%	38%	40%	41.6%	38.3%
Not Functioning	11	14	11	5	12	53
	0.3%	0.4%	0.3%	0.2%	0.4%	0.3%
Functioning Improperly	117	90	82	78	75	442
	3%	2.3%	2.4%	2.4%	2.3%	2.5%
Worn Reflect. Mater.	4	8	5	4	7	28
	0.1%	0.2%	0.1%	0.1%	0.2%	0.2%
Missing	1	0	2	0	1	4
	0%	0	0.1%	0	0%	0%
Other	37	53	59	51	46	246
	1%	1.4%	1.7%	1.6%	1.4%	1.4%
Total	3838	3858	3480	3264	3286	17726
	21.6%	21.8%	19.6%	18.4%	18.5%	100%

Missing = 963 cases

Driver and Pedestrian Actions

Vehicle Maneuver

Over all motor vehicle - pedestrian collisions, the majority (60 percent) involved vehicles traveling Straight Ahead (Table 18). Fourteen percent of collisions occurred when vehicles were making Left turns. Right turns accounted for about 7 percent of collisions. Backing vehicles accounted for nearly 5 percent. All other driver maneuvers accounted for less than 2% each, including Overtaking Vehicles (1.5 percent), Turning Right on Red (0.1%), Slow, Stop, Turning Right (1.2 percent), Slow, Stop, Turning Left (1.6 percent), and vehicles that were either Slowing/stopping for other reasons, or Starting in Traffic or Entering from Driveways and Alleys. While collisions involving straight ahead vehicles seem to have decreased in number and proportion over the study period, those involving left and right-turning vehicles have increased. Whether these changes are due to changes in the accuracy of the data reported over time or changes in the actual proportions of these types of collisions is unknown.

For ease in understanding, some of the less frequently occurring specific driver maneuvers have been combined in the figure below (Figure 13).

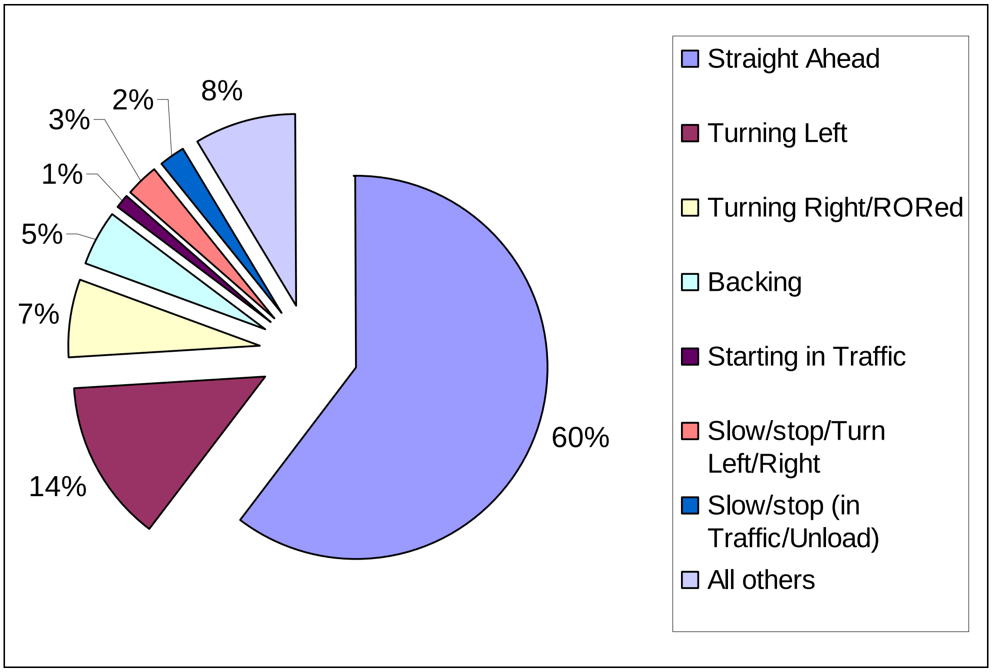

Figure 13. Vehicle maneuvers in collisions with pedestrians (2001-2005)

Table 18. Yearly Pedestrian Collisions by Vehicle Maneuver

Vehicle Maneuver	2001	2002	2003	2004	2005	Total
Straight Ahead	2413	2349	2108	1878	1753	10501
	63.8%	61.6%	61.1%	58.7%	55%	60.2%
Passing/Overtaking	56	57	56	52	42	263
	1.5%	1.5%	1.6%	1.6%	1.3%	1.5%
Turning Left	460	495	432	439	544	2370
	12.2%	13%	12.5%	13.7%	17.1%	13.6%
Turning Right	236	247	198	216	269	1166
	6.2%	6.5%	5.7%	6.8%	8.4%	6.7%
Turning Right on Red	3	3	7	5	4	22
	0.1%	0.1%	0.2%	0.2%	0.1%	0.1%
U-turn	6	12	4	7	3	32
	0.2%	0.3%	0.1%	0.2%	0.1%	0.2%
Starting in Traffic	44	36	39	32	42	193
	1.2%	0.9%	1.1%	1%	1.3%	1.1%
Slow/stop Turn Left	44	40	82	69	49	284
	1.2%	1%	2.4%	2.2%	1.5%	1.6%
Slow/stop Turn Right	34	53	53	39	21	200
	0.9%	1.4%	1.5%	1.2%	0.7%	1.2%

Vehicle Maneuver	2001	2002	2003	2004	2005	Total
Slow/stop Unload	17	18	18	22	25	100
	0.4%	0.5%	0.5%	0.7%	0.8%	0.6%
Slow/stop in Traffic	47	62	60	78	65	312
	1.2%	1.6%	1.7%	2.4%	2%	1.8%
Driving Wrong Way	7	11	8	8	10	44
	0.2%	0.3%	0.2%	0.2%	0.3%	0.2%
Changing Lanes	10	18	17	14	8	67
	0.3%	0.5%	0.5%	0.4%	0.2%	0.4%
Avoiding Vehs/Objects	24	37	36	23	18	138
	0.6%	1%	1%	0.7%	0.6%	0.8%
Skidding/Loss of control	29	32	24	26	20	131
	0.8%	0.8%	0.7%	0.8%	0.6%	0.8%
Entering from Parking	19	13	15	9	19	75
	0.5%	0.3%	0.4%	0.3%	0.6%	0.4%
Leaving Parking	8	7	5	6	2	28
	0.2%	0.2%	0.1%	0.2%	0.1%	0.2%
Merging	1	3	2	3	4	13
	0%	0.1%	0.1%	0.1%	0.1%	0.1%
Diverging	0	0	1	2	0	3
	0	0	0%	0.1%	0	0%
Enter from Driveway/Alley	31	24	18	20	21	114
	0.8%	0.6%	0.5%	0.6%	0.7%	0.7%
Parked	8	5	6	58	46	123
	0.2%	0.1%	0.2%	1.8%	1.4%	0.7%
Parked in Traffic Lane	7	5	4	1	5	22
	0.2%	0.1%	0.1%	0%	0.2%	0.1%
Backing	174	173	170	139	151	807
	4.6%	4.5%	4.9%	4.3%	4.7%	4.6%
Driverless	10	12	2	1	0	25
	0.3%	0.3%	0.1%	0%	0	0.1%
Other	95	102	86	53	67	403
	2.5%	2.7%	2.5%	1.7%	2.1%	2.3%
Total	3783	3814	3451	3200	3188	17436
	21.7%	21.9%	19.8%	18.4%	18.3%	100%

Missing = 1250

Some types of maneuvers were, of course, more common for intersection-related collisions including left turns (25 percent of intersection collisions) and right turns (12 percent) compared with non-intersection-related collisions (5 percent and 2 percent, respectively – likely at driveways and alleys) (Table 19). A majority of collisions that were not intersection-related (70 percent) involved straight through vehicles, while about 48 percent of intersection-related collisions involved through vehicles. Other types of maneuvers tended to account for relatively small proportions of collisions at either type of location, although backing vehicle crashes are more common in non-intersection locations (nearly 7 percent compared with 2 percent for intersection-related). Additionally, some types of collisions could only occur at particular locations. For example, turning right on red would only occur at signalized intersections, whereas other turning maneuvers could occur at intersection or driveway/alley locations. There are apparently some errors in these data, as reflected by 4 right-turn-on-red collisions indicated for non-intersection related. Vehicle maneuver data could also be examined in conjunction with pedestrian location and pedestrian actions, and type of traffic control, for a more complete understanding of the types and locations of collisions occurring.

Table 19. Vehicle Maneuver by Intersection-related Collision (2001-2005)

	Intersection-related?		
Veh maneuver	**No**	**Yes**	**Total**
Straight Ahead	6855 69.9%	3646 47.5%	10,501 60.2%
Passing/Overtaking	176 1.8%	87 1.1%	263 1.5%
Turning Left	463 4.7%	1907 25%	2370 13.6%
Turning Right	243 2.5%	923 12.1%	1166 6.7%
Turning on Red	4 0%	18 0.2%	22 0.1%
U-turn	21 0.2%	11 0.1%	32 0.2%
Starting in Traffic	90 0.9%	103 1.4%	193 1.1%
Slow/stop Turn Left	68 0.7%	216 2.8%	284 1.6%
Slow/stop Turn Right	74 0.8%	126 1.6%	200 1.2%
Slow/stop Unload	54 0.6%	46 0.6%	100 0.6%
Slow/stop in Traffic	167 1.7%	145 1.9%	312 1.8%
Driving Wrong Way	33 0.3%	11 0.1%	44 0.2%
Changing Lanes	54 0.6%	13 0.2%	67 0.4%
Avoiding Vehicles/Objects	112 1.1%	26 0.3%	138 0.8%
Skidding/Loss of Control	83 0.8%	48 0.6%	131 0.8%
Entering from Parking	69 0.7%	6 0.1%	75 0.4%
Leaving to Park	26 0.3%	2 0%	28 0.2%
Merging	10 0.1%	3 0%	13 0.1%
Diverging	0 0	3 0%	3 0%
Enter from Driveway/Alley	104 1.1%	10 0.1%	114 0.6%
Parked	110 1.1%	13 0.2%	123 0.7%
Parked in Traffic Lane	17	5	22

	Intersection-related?		
Veh maneuver	**No**	**Yes**	**Total**
	0.2%	0.1%	0.1%
Backing	658	149	807
	6.7%	2%	4.6%
Driverless Vehicle	20	5	25
	0.2%	0.1%	0.1%
Other	295	108	403
	3%	1.4%	2.3%
Total	9806	7630	17436
	56.2%	43.8%	100%

Missing = 1250

Driver Action
Another driver-related factor is “Driver Action” – which seems similar to a driver contributing circumstances field (data not shown). The most commonly cited driver action was Failure to Yield (38 percent), None was cited for nearly 20 percent, and Too Fast for Conditions for slightly more than 2 percent. Improper backing was also cited in 2 percent of cases. A variety of other actions, such as Improper Turns, Improper Lane Change, Improper Passing, and Wrong Way, were indicated less than 1 percent of the time. Unknown action accounted, however, for 22 percent, and Other for nearly 12 percent of the total.

Driver Vision
There is also a field indicating whether the driver’s vision was obscured. In 80 percent of cases, no obstruction was noted (data for all five years). The most commonly cited obstructions were parked vehicles (6.5 percent), other (4.9 percent), moving vehicles (3.5 percent), water/ice on windshield (2.3 percent) and sun blinding (2.2 percent). There are indicators for other objects such as embankments, buildings, signs, plants, etc., and this field may be useful to examine for site-specific analyses to determine where vision may be obscured and a remedy provided. (Data were missing for 7300 cases for al five years.)

Pedestrian Location
For all ages, more than half of pedestrians were indicated to be In the Roadway at the time of the crash (Table 20). This position most likely represents being in the roadway, but not in a crosswalk area (designated or undesignated). How aware police officers are of undesignated crosswalks is, however, unknown. About 32 percent were struck while in a crosswalk, nearly 7 percent were not in an available crosswalk, and another 1 percent were struck at a driveway crossing or were otherwise not in the roadway when struck.

Table 20. Yearly Collisions by Pedestrian Location prior to the Collision

Ped location/position	2001	2002	2003	2004	2005	Total
In Roadway	2153 57.9%	2055 55.5%	1781 54.1%	1584 53.9%	1453 51.4%	9026 54.8%
In Crosswalk	1106 29.7%	1144 30.9%	1043 31.7%	1000 34%	1008 35.7%	5301 32.2%
Not in Available Crosswalk	248 6.7%	231 6.2%	239 7.3%	172 5.8%	191 6.8%	1081 6.6%
Crosswalk Not Available	70 1.9%	82 2.2%	81 2.5%	48 1.6%	50 1.8%	331 2%
Driveway Access	43 1.2%	53 1.4%	36 1.1%	35 1.2%	32 1.1%	199 1.2%
Not in Roadway	99 2.7%	139 3.8%	113 3.4%	102 3.5%	91 3.2%	544 3.3%
Total	3719 22.6%	3704 22.5%	3293 20%	2941 17.8%	2825 17.1%	16482 100%
Missing	2204					

There were differences by age, however, and younger pedestrians were especially likely to be indicated as “being in roadway” prior to the crash (71 percent of the time, consistent with mid-block dart-outs and dashes) (Figure 14). Older pedestrians were more likely to be in a crosswalk when struck (about 45% of the time). (In Figure 14, ages with similar location distributions are grouped together.) Children were also more likely to not use an available crosswalk than adults but were less likely to be struck in a non-roadway location.

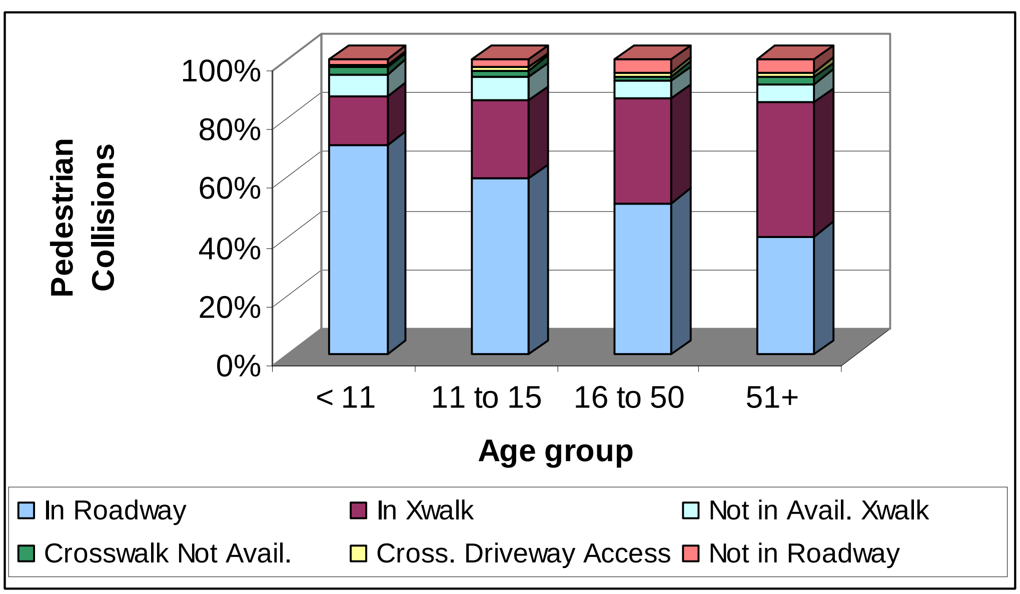

Figure 14. Pedestrian location by age group (2001-2005)

Pedestrian location also varied depending on whether the collision was indicated to be intersection-related or not. When the crash was indicated to be intersection-related, the pedestrian position of "In Roadway" accounted for one-third (33 percent) of collisions for all five years, while a majority (60 percent) of pedestrians were indicated to be in a crosswalk (Table 21). Conversely, 72 percent of pedestrians were coded to be "In the Roadway" when the collision was not intersection-related. Ten percent were indicated to be in a crosswalk and another 9 percent were not in an available crosswalk when the collision was not related to an intersection. (Some reviewers felt that this percentage is high relative to the frequency of mid-block crosswalks in Chicago, but officers may be interpreting this field to indicate that the pedestrian did not go to a nearby intersection crosswalk.) By comparison, 3 percent of pedestrians involved in intersection collisions were indicated not to be in an available crosswalk when struck.

Table 21. Pedestrian Position by Intersection-related Collision Location (2001-2005)

	Intersection-related?		
Ped position	**No**	**Yes**	**Total**
In Roadway	6633	2393	9026
	72.3%	32.8%	54.8%
In Walk	914	4387	5301
	10%	60%	32.2%
Not in Avail. Crosswalk	827	254	1081
	9%	3.5%	6.6%
Crosswalk Not Available	194	137	331
	2.1%	1.9%	2%
Driveway Access	182	17	199
	2%	0.2%	1.2%
Not in Roadway	426	118	544
	4.6%	1.6%	3.3%
Total	9176	7306	16482
	55.7%	44.3%	100%

Missing = 2204

Pedestrian Action

The following table (Table 22) provides information about what the pedestrian was doing just prior to the collision (ranked in decreasing order). While there are a variety of types of actions to examine, this information can provide insight regarding events leading up to the crash (similar to crash-type codes such as those generated by PBCAT software Harkey et al., 2006). This field may prove useful especially when conducting site-specific analyses in conjunction with Vehicle Maneuver and Driver Action fields to gain an understanding of both driver and pedestrian actions leading up to the crash. As mentioned previously, other location and traffic control characteristics could also be examined in connection with these data.

The most common pedestrian actions were reportedly Crossing with the Signal (24 percent, indicating a possible problem with motor vehicle yielding compliance), followed by Crossing Against a Signal (13 percent), and Crossing Not at an Intersection (9 percent). Another 9 percent were indicated to be Standing in the Roadway, while around 5 to 6 percent each were Walking Against Traffic and Playing in the Roadway. Walking with Traffic accounted for about 4 percent. The remaining types of pedestrian actions accounted for 2 percent or fewer, with the exception of Other Action, which accounts for 22 percent of the total. A majority of these Other collisions may not be easy to assign a specific action, but there may be some additional types of codes that could capture a significant portion of these remaining prior actions. For example, there doesn't seem to be a code to capture pedestrians crossing at sign-controlled (or non-signalized) intersections. It is not clear what a few of the codes, such as "Turning Left" and "Turning Right" mean in the context of pedestrian actions, and may be miscoded actions that are more pertinent to bicyclists or motorists, but the numbers involved are small. Consideration could be given to separating pedestrian and bicyclist actions on the police reporting form, and reviewing/revising the actions included on the crash reporting form, to help reduce reporting errors.

Table 22. Yearly Collisions by Pedestrian Action prior to the Collision

Ped Action	2001	2002	2003	2004	2005	Total
Crossing - With Signal	834 22.8%	860 23.5%	749 23.2%	700 24.7%	692 25.3%	3835 23.8%
Crossing - Against Signal	549 15%	486 13.3%	473 14.7%	351 12.4%	301 11%	2160 13.4%
Crossing Not at Intersection	415 11.3%	363 9.9%	273 8.5%	240 8.5%	204 7.4%	1495 9.3%
Standing in Roadway	330 9%	317 8.7%	287 8.9%	212 7.5%	226 8.3%	1372 8.5%
Walking Against Traffic	173 4.7%	199 5.4%	175 5.4%	174 6.2%	177 6.5%	898 5.6%
Playing in Roadway	226 6.2%	204 5.6%	171 5.3%	127 4.5%	123 4.5%	851 5.3%
Walking With Traffic	100 2.7%	118 3.2%	96 3%	131 4.6%	192 7%	637 4%
No Action	45 1.2%	71 1.9%	79 2.4%	52 1.8%	56 2.0%	303 1.9%
Working in Roadway	66 1.8%	59 1.6%	51 1.6%	58 2.0%	36 1.3%	270 1.7%
Enter from Driveway/alley	55 1.5%	49 1.3%	51 1.6%	40 1.4%	37 1.4%	232 1.4%
Parked Vehicle (entering/leaving/crossing)	45 1.2%	45 1.2%	39 1.2%	43 1.5%	48 1.8%	220 1.4%
Playing/Working on Vehicle	18 0.5%	21 0.6%	12 0.4%	10 0.4%	15 0.6%	76 0.5%
Turning Right	8 0.2%	11 0.3%	14 0.4%	10 0.4%	8 0.3%	51 0.3%
Turning Left	12 0.3%	8 0.2%	7 0.2%	10 0.4%	3 0.1%	40 .2%
School Bus in 50 ft (entering/leaving/crossing)	9 0.2%	9 0.2%	5 0.2%	5 0.2%	5 0.2%	33 0.2%
Walking to/from Disabled Vehicle	6 0.2%	3 0.1%	5 0.2%	5 0.2%	3 0.1%	22 0.1%
Waiting for School Bus	5 0.1%	5 0.1%	3 0.1%	4 0.1%	4 0.2%	21 0.1%
Other Action	765 20.9%	827 22.6%	732 22.7%	659 23.3%	607 22.2%	3590 22.3%
Total	3661 22.7%	3655 22.7%	3222 20%	2831 17.6%	2737 17%	16106 100%

Missing = 2580

Spatial Analyses

Spatial analyses conducted at the City's request focused on examining crashes by Ward (geo-political areas of the City), spatial analyses of school-related pedestrian collisions, density analyses, and analyses to identify intersections with high counts of pedestrian collisions. Geo-coded data for 2004 were incomplete, so the analyses below combined data from 2003 (obtained from CMAP) and 2005 (obtained from the state crash files).

Frequency Analysis by Wards

Geopolitical wards (provided in a shapefile by the City) were used to select crashes to obtain a distribution of crash frequency by ward. There are 50 wards, comprising the 234 square miles of the City of Chicago. Figure 15 illustrates the geographic results of frequency analysis by wards, where darker areas indicate those wards with higher frequency of pedestrian collisions in years 2003 and 2005, combined. Detailed information about the wards with top crash frequencies (top 20) are shown in Appendix 2.

The area with the highest crash count is the downtown region (ward 42), where the pedestrian collision count for 2003 and 2005 combined reached 537.

The five wards with the highest pedestrian collision counts for 2003 and 2005 combined (all above 200) were:

- Ward 42 – 537 pedestrian collisions
- Ward 2 – 324 pedestrian collisions
- Ward 28 – 286 pedestrian collisions
- Ward 17 – 231 pedestrian collisions
- Ward 6 – 206 pedestrian collisions

(The wards highlighted above were also identified in the high crash density analyses, described in the following section.)

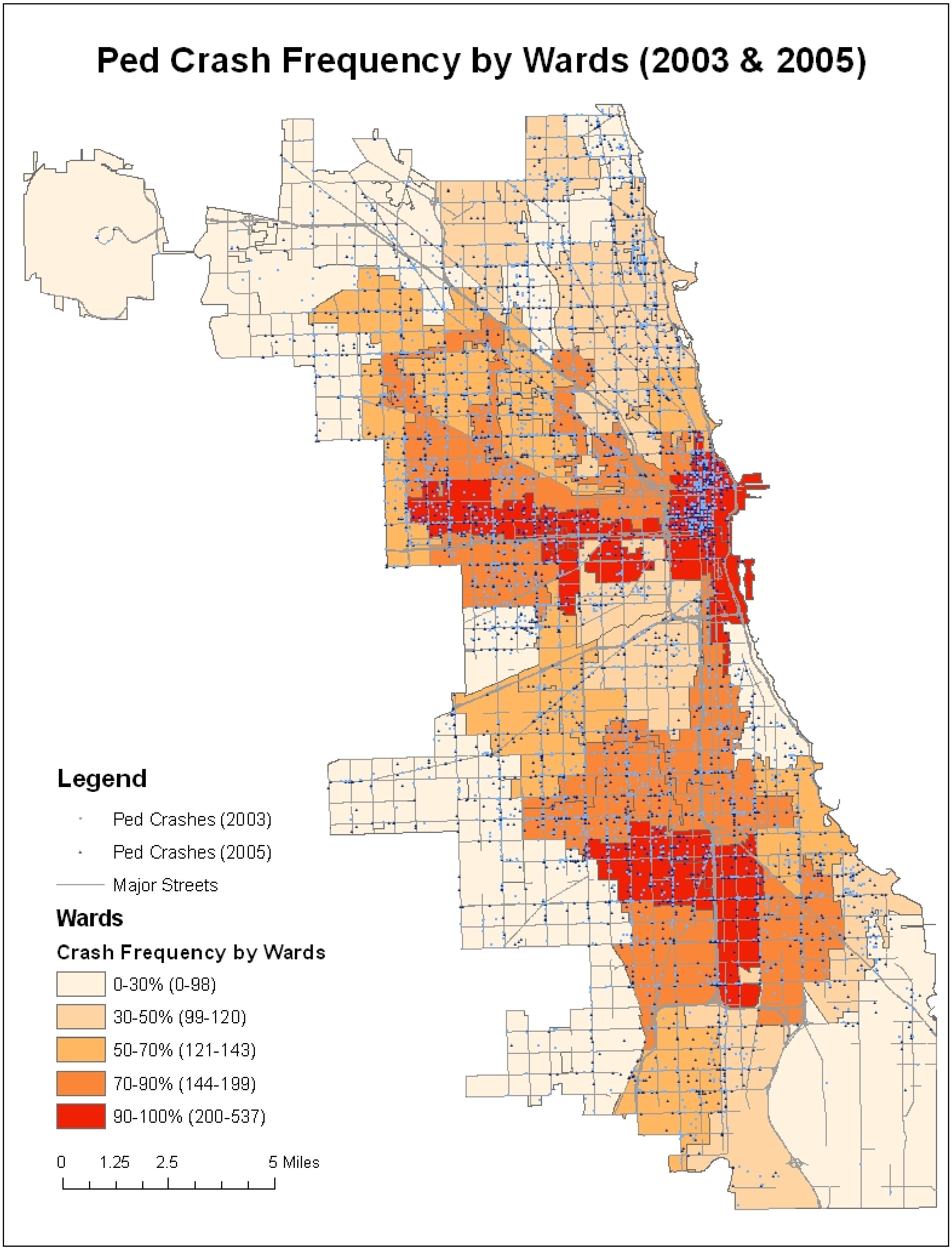

Figure 15. Pedestrian Crash Frequency by Wards (2003 & 2005)

Note: The percentage shown under the “Crash Frequency by Wards” legend means the relevant percentile interval associated with each colored category; and the corresponding value inside the parentheses indicates the real numerical (crash count) interval for that category.

Density Analysis by Wards

As one method of normalizing pedestrian collision counts within each ward, a crash density analysis by mile of roadway was also performed. (Other methods could include normalizing by population or actual pedestrian counts.) The basic formula used to calculate crash density by ward is shown as follows:

$$\text{crash density (by ward)} = \frac{\text{crash frequency (per ward)}}{\text{total mileage of street network (per ward)}}$$

...........Equation 1

To be noted here, when calculating total mileage of street, we excluded streets whose types were "expressway", "highway", "on-ramp", and "off-ramp". These types of roads or segments were excluded because they are thought to have little pedestrian activity in general. Instead, they are dominated by auto related travel, and they may have specific barriers that prevent access by pedestrians.

Crash density was then indexed by relating the crash density for each ward against the density City-wide. The formula used is shown in Equation 2.

$$\text{crash density index (by ward)} = \frac{\text{crash density (per ward)}}{\text{total number of crashes / total mileage of streets}}$$

...........Equation 2

Geographic results of density index analysis by wards are shown in Figure 16, where darker color indicates those areas with a higher density index of pedestrian crashes in 2003 and 2005, combined. The ward index rankings candidates with high crash density measure, as well as high crash density index measure (top 20) are listed in Table 6.

Similar to the crash frequency analysis results, the downtown area again ranks highest, this time in terms of its relative crash density/mile of roadway index. With 29.49 crashes per street mile (for two years, or 14.745 crashes per year per street mile), the downtown area has a crash density index equal to 4.48 times the overall density. Thus, the crash density for 2003 and 2005 pedestrian crashes in the downtown area is about 4.5 times that for the entire City of Chicago (6.6 crashes per street mile on average for two years, or 3.3 crashes per year per street mile). (Since the index is a relative measure, it is not necessary to divide by the number of years.)

The five wards with the highest crash density/street mile index rankings were as follows:

- Ward 42 – pedestrian collision density index = 4.48
- Ward 17 – pedestrian collision density index = 2.33
- Ward 15 – pedestrian collision density index = 2.1
- Ward 28 – pedestrian collision density index = 2.1
- Ward 48 – pedestrian collision density index = 1.77

The top twenty index rankings are included in Appendix 3. While 3 of the top 5 wards identified (highlighted above, and on p. 38) are the same in both the density index and the count or frequency ranking, 8 of the top 20 wards (Appendix 3) identified are different. Whether normalization based on differences in crash density per mile of roadway reflects a crash rate that accounts for differences in pedestrian exposure among the wards is not certain, but such a measure could be considered when attempting to prioritize and rank efficiency of treating high crash segments or miles of roadway.

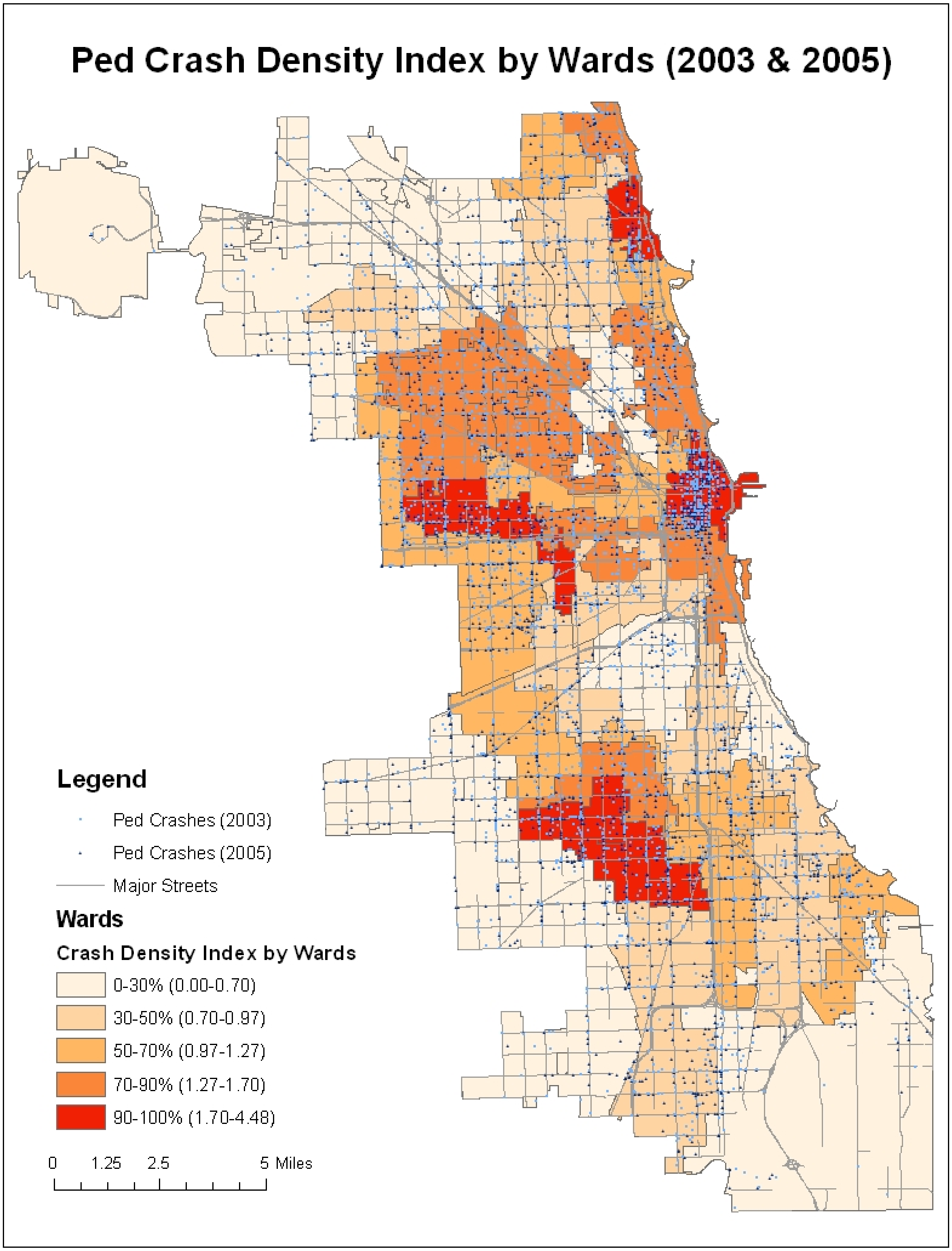

Figure 16. Pedestrian Crash Density Index by Wards (2003 & 2005)
Note: The percentage shown under the "Crash Density Index by Wards" legend means the relevant percentile interval associated with each colored category; the corresponding value inside the parentheses indicates the real numerical crash interval for that category.

Spatial Density Analysis of Pedestrian Crashes

In addition to the frequency analysis and the street mileage related density analysis by ward, spatial density analysis of pedestrian crashes was also used in this study. In simple dot maps, multiple crashes might occur at the same location or close enough that the actual density of crashes cannot be easily observed or quantified. Spatial density analysis is a way of overcoming this limitation and determining crash density per area relative to overall density and displaying the information. Additionally, the identification of high crash areas is not limited by ward or other boundaries (except the edges of the map). CrimeStat was selected to calculate the crash density estimates and ArcGIS was used to display spatial allocation of the corresponding crash density estimates. CrimeStat is a spatial statistics program for the analysis of crime incident locations, developed by Ned Levine & Associates (Levine, 2004). In this analysis, pedestrian crashes were defined as the incidents, instead of crimes. ArcGIS is an integrated collection of GIS software products for compiling, authoring, analyzing, mapping and publishing geographic information, developed by the Environmental Systems Research Institute, Inc. (ESRI).

To be more specific, kernel density analysis was used, which calculates the density of point features (pedestrian crashes in both 2003 and 2005) in a neighborhood around each crash location, i.e., within each output raster cell. Crash data with spatial information were first input into CrimeStat for generating kernel density of pedestrian crashes. Several parameters used in the kernel density analysis are described as follows:

- The raster cell size was set to 528*528 feet (0.1*0.1 mile).
- Interval of bandwidth, which determines the smoothness of the estimated density surface, was set to 0.5 mile, because this value is appropriate for a large-size city like Chicago.
- The density estimate for each cell was calculated in an output unit of “relative densities,” which was the absolute density divided by the grid cell area. In our study, it was expressed in crashes per square mile.

The kernel density estimates for all raster cells were output from CrimeStat to ArcGIS in a shape file format, and illustrated in a map (Figure 17). There are six areas highlighted in Figure 17 and whose kernel density is above the 98 percentile compared to the average density for the entire city area. The downtown area again is included in the highest crash density areas, which is consistent with the result from the frequency and density analysis by ward.

One shortcoming of kernel density analyses for collisions occurring on a street network is that the method searches in planar space – that is a radius in all directions from a crash point – as opposed to searching along the street network where these reported crashes should be located. However, at the scale employed here, the method is considered useful for identifying broad areas where crash concentrations are higher than in other areas. There is significant overlap with the highest crash zones identified by the earlier methods, but there is improved detail and some additional areas were differentiated by this method.

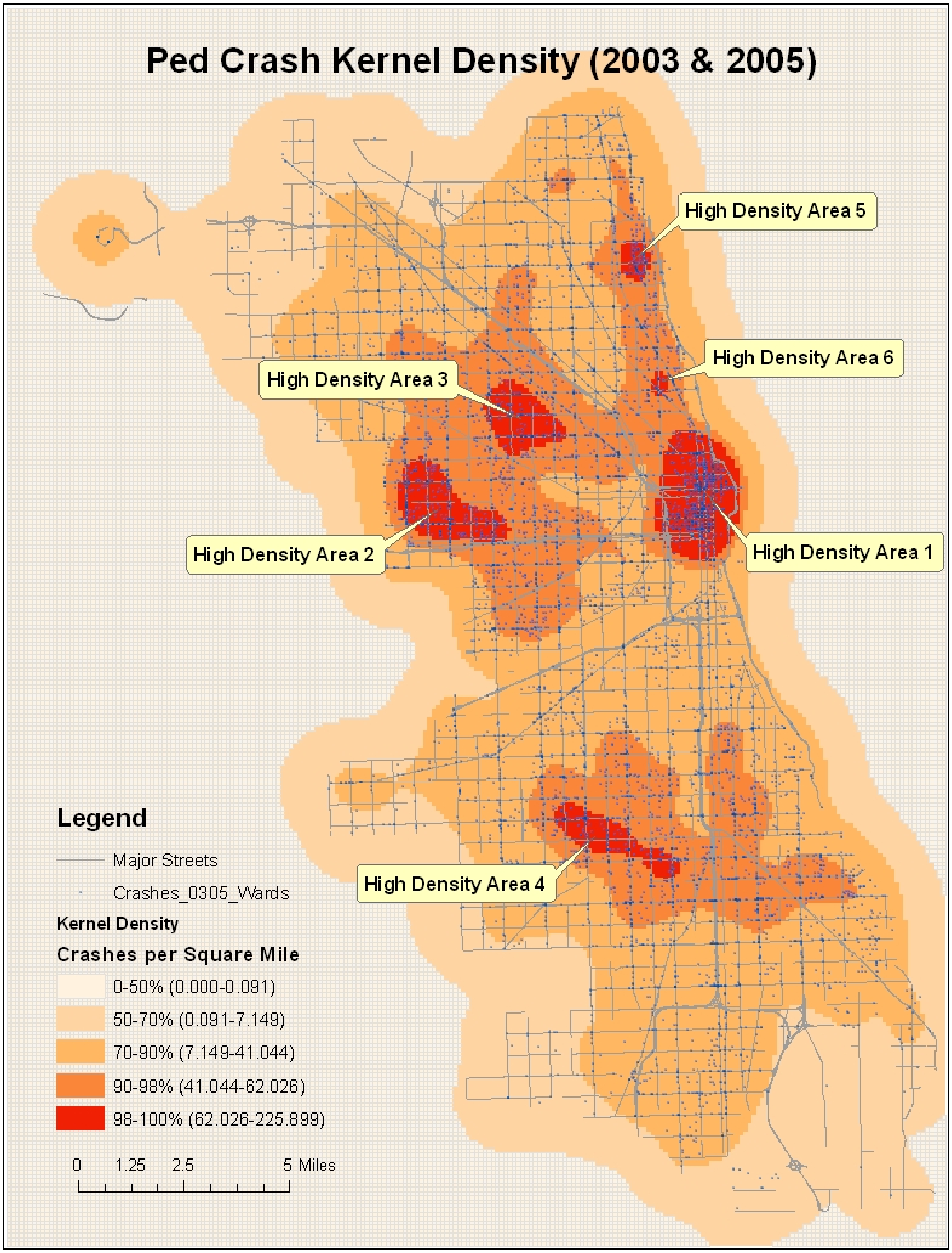

Figure 17. Pedestrian Crash Kernel Density (2003 & 2005)

Note: The percentage shown under the "Crashes per Square Mile" legend indicates the relevant percentile interval associated with each colored category; the corresponding value inside the parentheses indicates the real numerical crash interval for that category.

School Related Crash Analyses

School related crash analyses were also employed in this study at the City's request. Descriptive statistics also indicated that there were significant numbers and proportions of pedestrian collisions occurring during morning and especially after-school travel times, and involving school-aged children.

During the school-related crash analysis process, geo-coded school information was first input into ArcGIS. The shapefile contained 636 schools within the Chicago city boundary. Since schools associated with younger school-aged children were the focus of this analysis, 515 schools were selected, which included all elementary, middle, and charter schools with grades less than grade nine. A one-quarter mile buffer was further created for these 515 selected schools.

For the combined 2003/2005 data, 61.8 percent of all crashes (4367 out of 7064) occurred within a quarter mile buffer of all (public) elementary schools; 19.5 percent of all crashes (1378 out of 7064) involved children whose ages were greater than 4 but less than 15.

The first analysis included crashes within the ¼ mile school buffer area that involved school-aged children (aged 5 to 14), occurred between the hours of 7 and 9 am, or between 2 and 4 pm, and on a weekday (Monday through Friday). (Collisions that occurred during the summer months were not, however, excluded, but this could be done in future analyses.)

In 2003, there were totally 298 (out of 3649 = 8.2 percent) crashes that involved children aged from 5 to 14, and occurred between Monday and Friday school travel times (7:00-9:00 am or 2:00 – 4:00 pm). Among those, there were 263 (out of 298 = 88.3 percent) crashes that happened within 1/4 mile buffer of selected schools (with grade less than 9). In 2005, there were totally 240 (out of 3415 = 7 percent) crashes that involved children aged from 5 to 14 years, occurred between Monday and Friday school time. Among those, there were 190 (out of 240 = 79.2 percent) crashes that happened within 1/4 mile buffer of selected schools.

A map was created to display the results (Figure 18). The top 15 schools with highest crash numbers were highlighted and are also shown in Table 23. The schools highlighted in Table 23 were also identified in the following, more general, school-based analyses.

Table 23. Schools with Highest Numbers of Crashes involving School-aged Children and occurring during Typical School-related Travel Times (2003 & 2005)

Rank	School Name	Crash Count
1	Bouchet	9
2	Mozart	5
3	Brennemann	4
3	McCutcheon	4
3	Tilton	4
3	South Chicago Comm.	4
3	Claremont Academy	4
3	Lloyd	4
3	Arai Middle	4
3	May	4
3	McCosh	4
3	Bradwell	4
3	Clinton	4
3	Kanoon	4
3	Hay	4

Note: Schools refer to all elementary schools and charter schools with grade less than grade 9; school related crashes refer to crashes that involved children age from 5 to 14, occurred between Monday and Friday school time (7:00 to 9:00 am or 2:00-4:00pm). [The highlighted schools were also identified by the more general (less exclusive) method.]

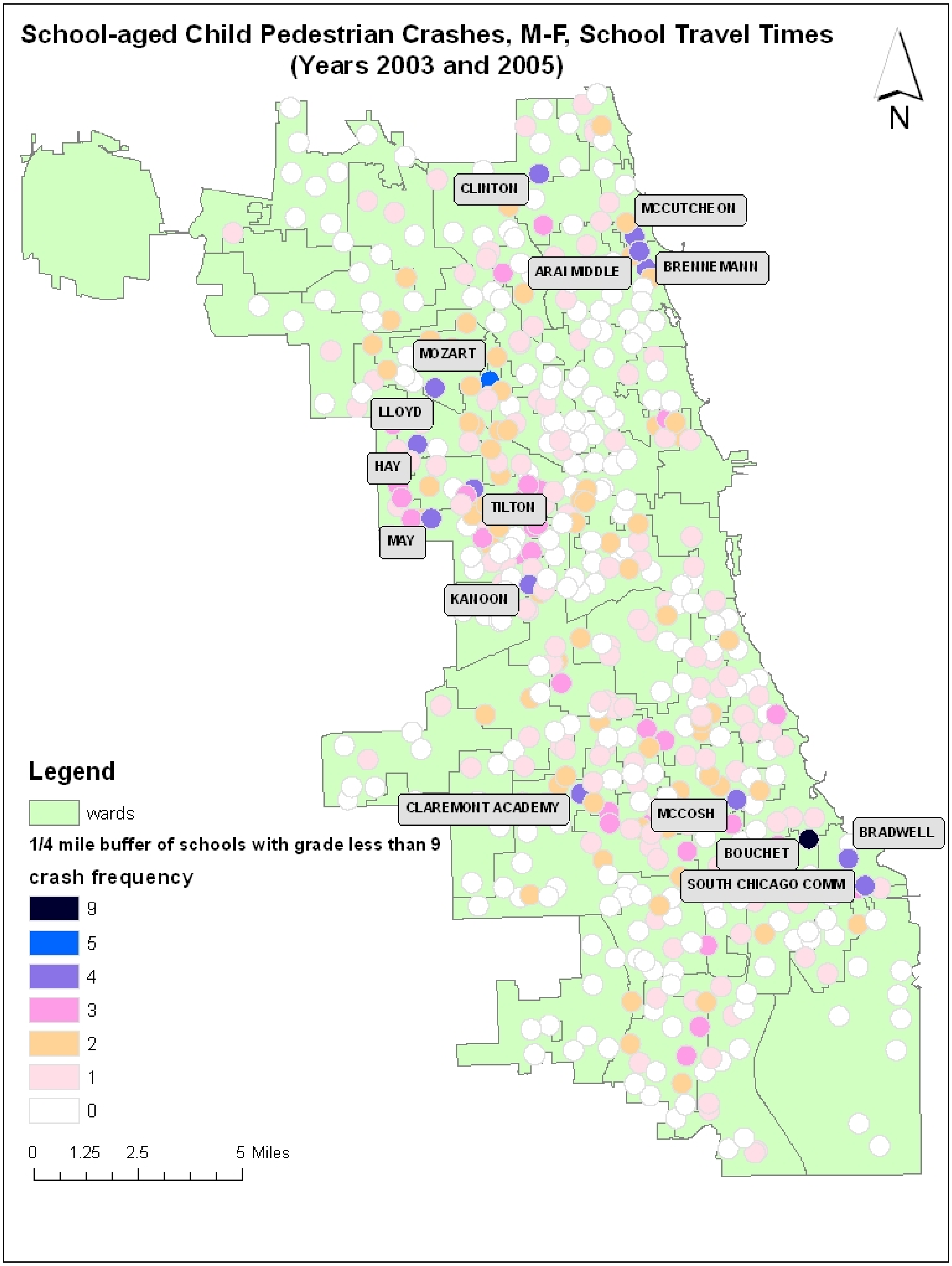

Figure 18. School-related Travel Pedestrian Crash Analysis (2003 and 2005)

Note: Schools refer to all public schools and charter schools with grades less than grade 9; school related crashes refer to crashes that involved children aged from 5 to 14, occurred between Monday and Friday school travel time (7:00 to 9:00 am or 14:00-16:00pm).

Since schools attract children to playgrounds and activities as well as adults and others during after-school hours and on weekends, an additional analysis was undertaken that included all pedestrian collisions that occurred within the ¼ mile buffer of a school at any time and involving any aged pedestrian (no age or time exclusions).

Again, a map was created to illustrate the results spatially (Figure 19), and the top 21 schools with highest crash counts were highlighted and also shown in Table 24. Each of the top 21 schools had total crash counts greater than 23 (the highest had 42) within the ¼ mile buffer area for the two years.

Only two schools selected based on collision counts of ascribed school-related travel involving child pedestrians were also selected by this more general method, Claremont Academy and McCutcheon. If schools are activity centers for people of all ages and at various times of day, or are simply located in areas of high pedestrian activity, then this latter method may be a useful alternative way to examine crash concentrations in the neighborhoods of schools.

Table 24. Schools with Highest Pedestrian Crash Counts within 1/4 mile buffer (2003 & 2005)

Rank	School Name	Crash Count
1	Ogden	42
2	Salazar	35
2	Ellington	35
4	Goudy	31
5	Emmet	29
6	Stewart	28
7	Dulles	26
7	Claremont Academy	26
7	Moos	26
10	McCutcheon	25
10	Lincoln	25
10	Howe	25
13	Hinton	24
13	Inter-American	24
15	Gillespie	23
15	Henson	23
15	Lathrop	23
15	Seward	23
15	Ruggles	23
15	Delano	23
15	Brunson	23

Note: Schools refer to all elementary schools and charter schools with grade less than grade 9. [The highlighted schools were also identified by the more specific method; see table 23]

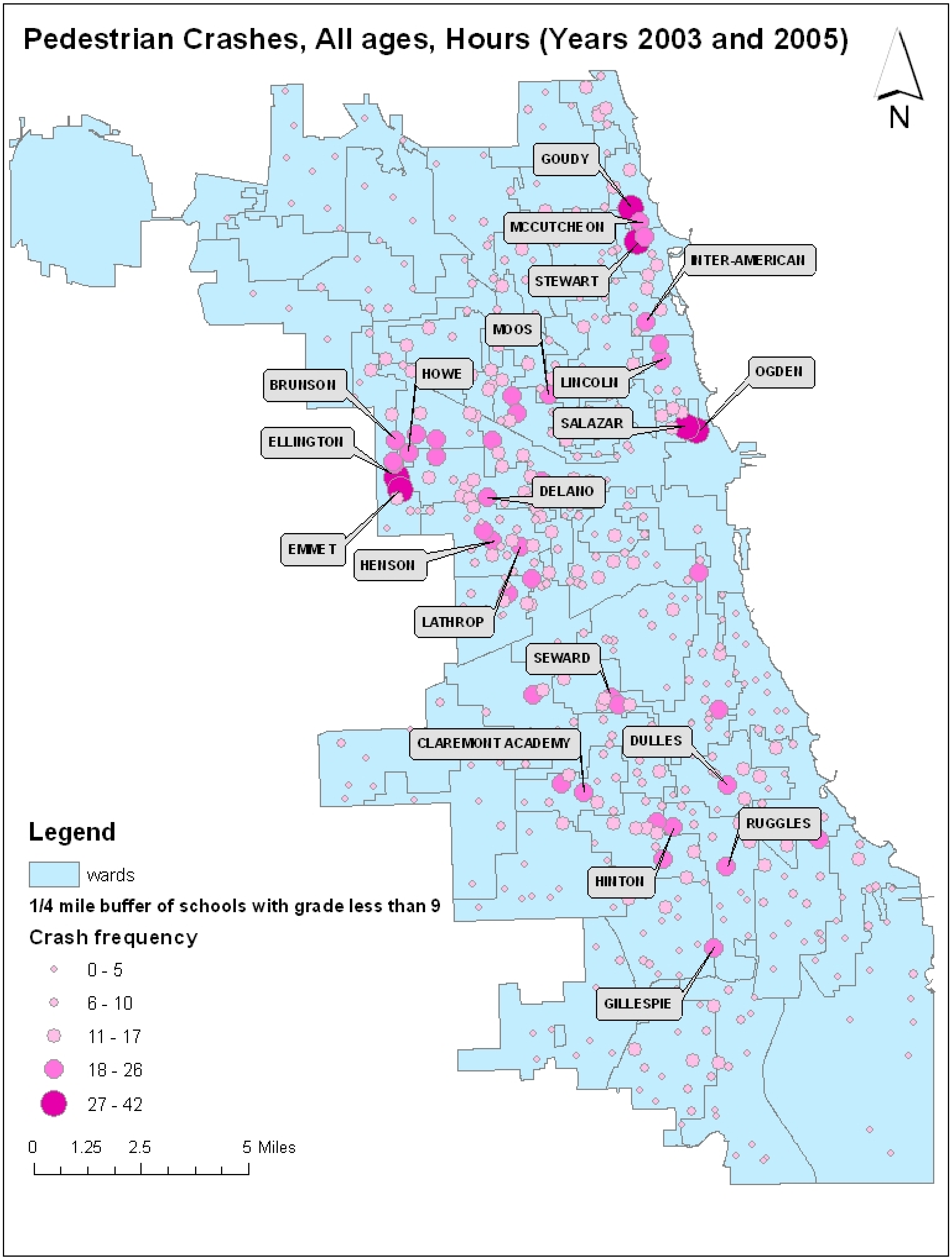

Figure 19. Pedestrian Crashes occurring within ¼ mile buffer of Schools (2003 & 2005)

Note: Schools refer to all elementary schools and charter schools with grade less than grade 9. Counts include all pedestrian collisions.

Senior Pedestrian Collisions

A map was also created of collisions that involved pedestrians aged 61 years and older (Figure 20). In 2003, 327 pedestrians aged 61 and older were involved in collisions with motor vehicles. In 2005, 316 pedestrians 61 and older were involved in collisions. It is difficult to visually detect a strong spatial trend in older pedestrian collisions. The trend seems similar to the overall concentrations of collisions. An analysis by ward (not illustrated) shows that six wards had 20 or more collisions involving pedestrians 61 years and older during the two years 2003 and 2005, including, as expected, ward 42 with 64 collisions. The top six wards for frequency of senior pedestrian collisions (for both years combined) were as follows:

- Ward 42 – 64 collisions involving ages 61+
- Ward 1 – 29 collisions
- Ward 2 – 25 collisions
- Ward 38 – 22 collisions
- Ward 45 – 20 collisions
- Ward 6 – 20 collisions

(There are also two wards with 19, two with 18, and two with 17 senior pedestrian collisions.)

Among the six wards with highest senior pedestrian collision counts, four of the wards (with 20 or more crashes, highlighted above) were also within the top 7 wards for crashes involving all ages (listed in Appendix 2). Two of the wards were newly identified (and were not in the top 20 wards for high all-ages pedestrian crashes). These two wards might, therefore, represent wards that have a greater senior crash problem relative to the overall problem due either to a higher population of senior pedestrians, locations or destinations involving senior pedestrians, or situations that pose problems to senior pedestrians above and beyond that posed to the general population. Examination of population and other characteristics by ward and in relation to senior housing and other facilities, and at a finer scale may help to elucidate whether either of these conjectures is the case.

A list of all of the wards with senior collision counts is included in Appendix 4.

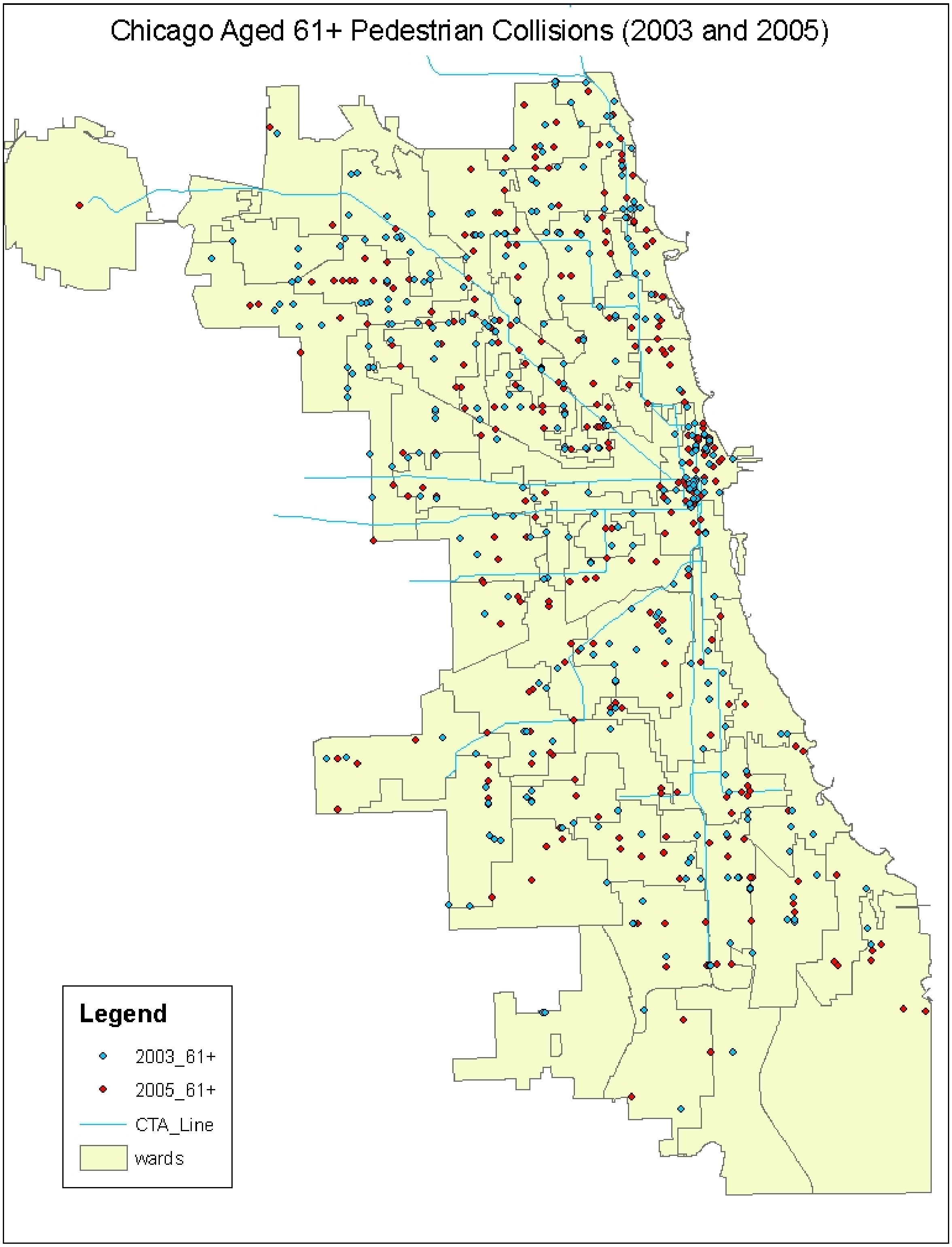

Figure 20. Spatial distribution of collisions involving pedestrians 61 years and older (2003 and 2005)

Intersection Analyses

Finally, we performed spatial analyses in an effort to identify intersections with high crash counts. An intersection (point) layer was needed in order to identify crashes near to intersections. A public domain extension for ArcView 3.X (http://arcscripts.esri.com/details.asp?dbid=11694) was used to create an intersection layer from the "trans" shapefile data provided by the City. This process created a point layer that should represent the intersection mid-points based on the intersection of the street (center line) segments. Line segments were consolidated to remove intermediate nodes/vertices to ensure that only actual intersections and dead-end streets were extracted. Dead-ends were also subsequently removed. A total of 26,698 intersection points were generated for the entire City. Data from a smaller intersection file (containing 2126 intersections identified by name of street and cross-street) and provided by the City were used to add intersection names to the matching intersections.

For this analysis, the intent was to capture collisions most likely to be occurring within the intersection proper. The next action was to create a buffer of 50 feet around the intersections. (It was thought that a radius of 50 feet from the intersection mid-point would be sufficient to capture the intersection proper including crosswalk areas and some smaller distance beyond for a majority of Chicago intersections. A larger/smaller buffer could be considered depending on street and intersection widths and whether one desires to capture collisions some distance from the intersection as well.) Finally, 2003 and 2005 pedestrian collisions that were within the 50' intersection buffers were selected. This action selected 1913, 2005 collisions and 1267, 2003 collisions, for a total of 3,180 pedestrian collisions City-wide (or 45 percent of 7064 total collisions for 2003 and 2005) as being within 50 feet of an intersection mid-point. In addition, 2267 intersections had one or more pedestrian collisions (within 50 feet) in these two years.

Further analyses selected the buffered intersections that encompassed 5 or more collisions. Maps were generated to display the results visually (Figure 21 and 22). The results are also included in table format in Appendix 5.

Forty-eight intersections throughout the City had five or more pedestrian collisions in 2003 and 2005, combined (Figure 21); one intersection had 13 collisions, and three had 9 to 11. Fifteen of the intersections with five or more collisions were within ward 42 that encompasses the downtown area (Figure 22). Further analyses of type of traffic control, signal timing and operations, lighting, proximity of CTA line, and crash factors such as driver and pedestrian actions could be completed. These high collision intersections would also be good candidates (based on high combined collision count for two years) to conduct site-specific analyses such as pedestrian safety audits.

Chicago Intersections with High Pedestrian Collision Counts

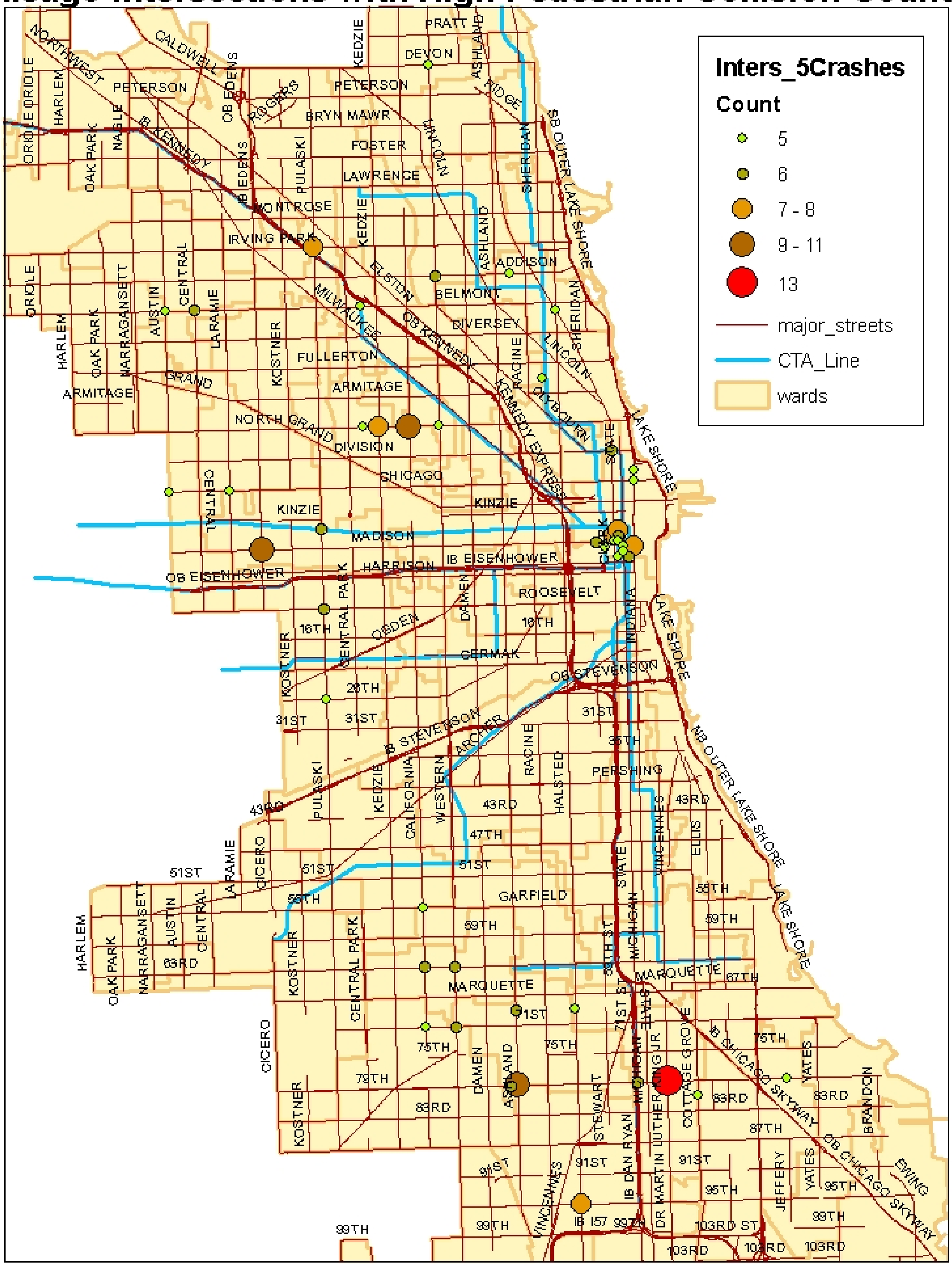

Figure 21. Chicago Intersections with 5 or more pedestrian collisions in 2003 and 2005

Ward 42 Intersections with High Pedestrian Collision Counts

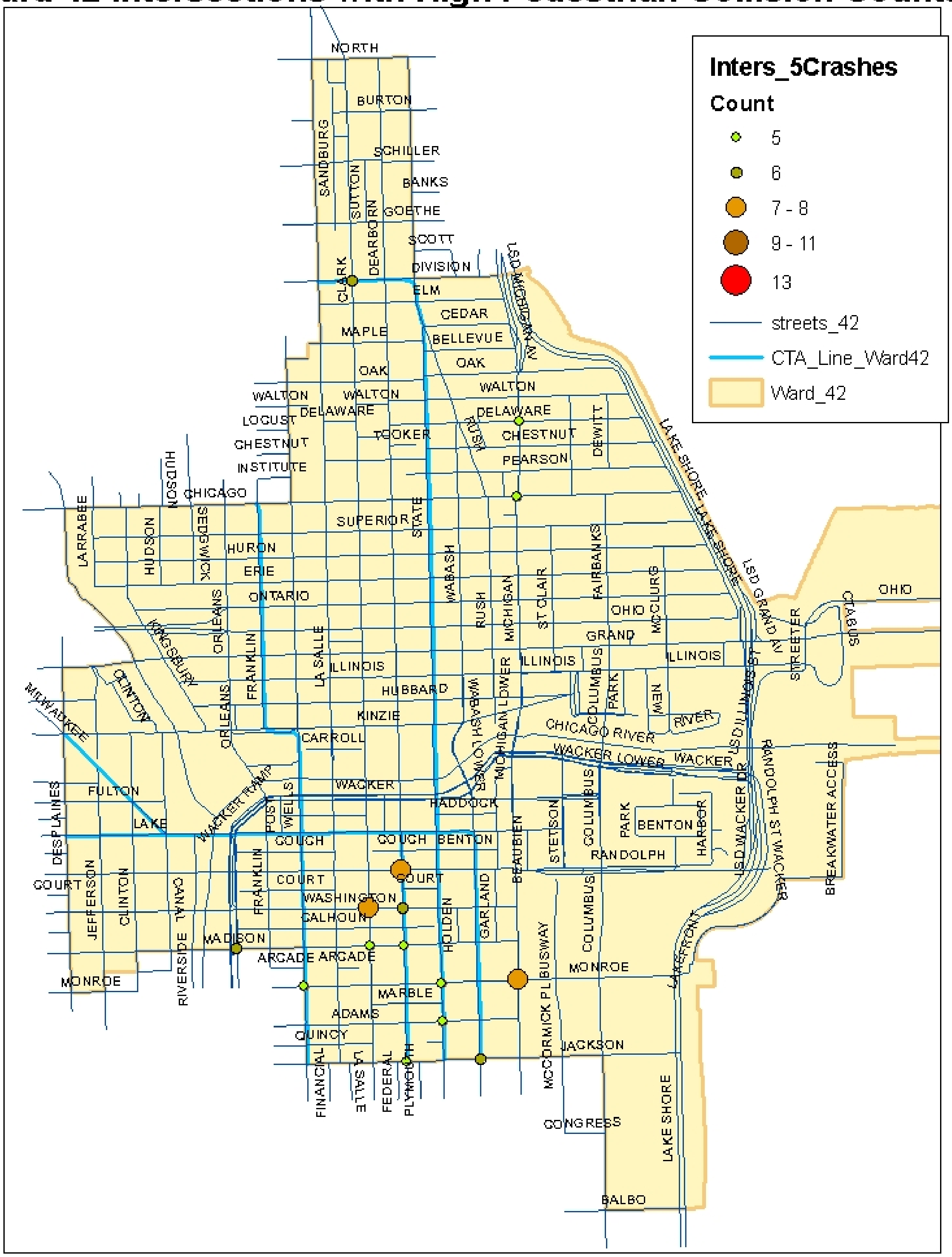

Figure 22. Ward 42 Intersections with 5 or more pedestrian collisions in 2003 and 2005

Summary of Key Results

For the entire City of Chicago, or at a macro-level of analysis, the following general results were found:

Crash Factors

- Pedestrian collisions have declined over the five year study period. Among males, crashes declined more than among females.

- Children up to age 15 represented about 28 percent of collision-involved pedestrians. Among youth, crashes also declined over the study period (hopefully not due to decreases in walking).

- Older pedestrians were less crash-involved than other age groups but suffered fatalities at a higher rate when struck.

- A majority of pedestrian collisions occurred during daylight hours and during peak afternoon to evening travel times (3 to 9 pm) during weekdays. Friday was the highest crash day on average. All ages were most crash-involved during peak afternoon hours, but especially school-aged children.

- Night-time collisions accounted for about 30 percent of pedestrian collisions, but 54 percent of fatal collisions. Additionally, the declines seen in pedestrian daylight collisions over the past few years have not occurred for night-time crashes.

- A majority of collisions occurred where no traffic control was identified and when motorists were traveling straight through.

- A majority of crashes were indicated not to be intersection-related; these data (and the method of identifying 'intersection-related') have, however, changed over the study period.

- For intersection-related collisions, about 47 percent of vehicles were traveling Straight Through, about 25 percent were turning left, and another 12 percent were turning right.

- For non-intersection-related collisions, about 70 percent of vehicles were Straight-through, about 5 percent were making Left Turns, 3 percent Right Turns, and about 7 percent involved Backing Vehicles.

- Seniors were more likely to be in a crosswalk when struck, especially at an intersection.

- Child pedestrians were more likely to be struck mid-block and not in a crosswalk. This and the preceding result are consistent with that found in other studies (see p. 27, Zegeer, Sandt, et al., 2006)

- About one-fourth of pedestrians were Crossing with a Signal when struck; 13 percent were Crossing Against the Signal, 9 percent were Crossing Not at an Intersection; about 8 percent were reported to be Standing in Roadway, 7 percent Walking with Traffic, 6 ½ percent Walking Against Traffic, and about 5 percent Playing in the Roadway. All other pedestrian actions accounted for about 2 percent or less each of collisions. Site-specific analyses utilizing these data could further efforts to identify appropriate countermeasures.

GIS/Spatial Analyses

- There are definite zones of pedestrian crash concentration – by raw frequencies per ward and by density per mile of roadway, and by spatial density analysis relative to overall crash density. The areas identified by any of these methods have significant overlap, but the kernel density analysis is not constrained by ward boundaries and may best capture zones of crash concentration.

- Schools with high collision counts were identified using two methods. The schools identified through high child-collision frequencies during typical school-travel times are different from those identified using all crashes (within the ¼ mi buffer). Both approaches may be valid for understanding crash problems in the vicinity of schools. Further study of the top crash locations is needed.

- Patterns of senior pedestrian collisions were not obviously spatially concentrated but further analyses could examine older pedestrian collisions in relation to population data, other neighborhood characteristics (senior centers, etc.), and other spatial factors.

- There were 48 intersections identified that had a total of five or more pedestrian collisions, with a maximum of 13 collisions, during the two years (2003 and 2005). Examination of hard copies of police crash reports could verify the accuracy of the crash locations, as well as provide detailed narratives and diagrams of the crashes. Again, further assessment, including on-site safety audits, of high crash locations is needed.

Discussion

The development and examination of crash data is an important first step in developing a plan to address pedestrian safety problems in the City of Chicago. For example, the data indicates that children up to age 15 accounted for 28 percent of pedestrian collisions in Chicago, many of which occurred during the after school hours of 3 to 6 pm. The City has already utilized and expanded on school-based analyses begun for this project and is working to develop programs to target child pedestrian collisions and further Safe Routes to School efforts.

High crash zones were identified through various spatial analyses (including density by area and density by roadway miles analyses). These zones could be targeted for further assessment of area-wide and more location-specific (intersection, corridor, segment) crash problems. Further analyses of high crash zones could also normalize data by population (as a proxy for exposure), actual pedestrian counts, or other measures.

Intersections (within 50 feet of midpoint) with high pedestrian crash counts were identified in this study. Forty-eight intersections were identified as having five or more (up to 13) pedestrian collisions within the two years for which geo-coded data were available (2003 and 2005). These intersections may be candidates for enforcement interventions as well as priority locations for additional site-specific assessments. (Local verification of crash locations should also be undertaken, particularly before focusing on any particular intersections.)

Once specific locations are identified, summary reports including relevant crash factors might be generated and taken to the field for on-site assessments of the specific crash characteristics in conjunction with roadway geometry and operations, and observations of pedestrian-motorist interactions. Such analyses can further efforts to develop specific countermeasures. Tools such as PEDSAFE (available at http://www.walkinginfo.org/pedsafe/) provide help in identification of potentially suitable countermeasures (Harkey and Zegeer, 2004). All countermeasures should be thoroughly assessed, however, by local traffic safety officials before implementation.

Other spatial examinations could focus on neighborhood population or built environment characteristics in conjunction with traffic crash characteristics. Such examination may help to target behavioral countermeasures including enforcement and educational programs as well as policy and engineering countermeasures. Further examination of the crash data, in combination with spatial distributions and neighborhood characteristics can help identify areas of concern for various factors or populations throughout the city. For example, the spatial distribution of Walking Against Traffic and Walking Facing Traffic collisions could be examined to determine where, and subsequently why pedestrians are apparently walking in the roadway. (Do reporting police officers understand these codes correctly or are there errors reporting the data at another step?) If the data are accurate, are there gaps in sidewalks, construction zones with no provision for pedestrians, or other problems that might be contributing to these behaviors, or are pedestrians simply choosing to walk in the street? For night-time collisions, are there gaps in lighting resulting in dark zones, poor maintenance of lighting, or actual roadways or segments where no lighting exists (as suggested by the Dark – Roadway Not Lighted category)? Both "Dark" categories could be combined to analyze whether there is insufficient lighting present at certain locations.

Some of the most useful information regarding collisions – the narrative and diagrams – are not available in electronic form; thus efforts to obtain copies of the original police crash reports prior to field assessments may also pay off in understanding of collision characteristics at specific locations (Zegeer, Sandt, et al. 2006, How to Develop a Pedestrian Safety Action Plan). Also, as described in the "How-To" guide, there are further limitations to electronic crash databases. In general, only collisions with motor vehicles are included, and collisions involving no injury may not be reported. Furthermore, some data fields are somewhat subjective and the accuracy of the data is dependent on several steps in the process, including initial accuracy in reporting the data, accuracy of data entry and encoding of crash variables. The accuracy of the geo-coded crash locations is also unknown, and locations could be verified when particular problem sites are assessed.

An effort has been made in this report to highlight data fields with obvious anomalies or potential errors. General recommendations to address data quality include providing training to police officers on pedestrian crash factors so they may be able to complete reports more accurately with respect to pedestrian collisions. Errors also enter the data at other steps, however, and there should be processes for data verification at data entry, and at data coding. The recent change in the crash report form and database has resulted in additional difficulties in comparing some data fields, especially since the new report forms were phased in over time, and some codes, particularly with respect to roadway characteristics were inconsistent year-to-year and contained significant errors. Additionally, some roadway information, such as speed limit or width of roadway, is not currently reported in the crash data. Some of these types of data might be available in roadway inventory files (but were not in the street shapefiles used in this study.)

Finally, since hard copies of the crash reports have not yet been examined, it is also possible that some collisions may incorrectly indicate 'pedestrian' that could, for example, be "pedalcyclist' and this fact could explain some of the anomalous data. Checking the data against hard copies of the crash reports would enable verification of the person type and many of the other data fields, as well as the spatial data (x, y coordinates). Improvements in the data for other fields such as driver and pedestrian physical condition, and BAC indicators, and number of travel lanes may demand more intensive action. Additionally, some fields may have more levels or codes than are useful and consideration could be given to reducing the complexity of some data fields. This change might free up time and energy for other useful items or help to improve the accuracy of what is recorded.

Nevertheless, based on the large volume of data available in a crash database, the data probably provide a fairly good representation of general crash problems. [2] Checking and data verification (including of geo-coded crash locations), along with officer training, could certainly help to improve the quality of the data.

The analyses presented here and further descriptions and analyses of pedestrian crash factors and spatial characteristics, along with other measures of the pedestrian environment such as facility inventories, lighting inventories, behavioral observations, geometric descriptions, and traffic counts and characteristics should all be used to identify appropriate countermeasures, and develop a pedestrian safety improvement program that will most effectively help to reduce pedestrian collisions in the City of Chicago.

It should also be borne in mind that collisions have a large 'stochastic' or chance component, and a high number of pedestrian collisions for two-years at a location may be expected to decline in future years even if no action is taken. Concurrently collisions may increase at other locations. Thus high crash intersections may also serve as 'example' intersections for the rest of the City, depending on how well they represent general crash problems that may occur City-wide or that relate to a number of similar Chicago intersections. The same type of approach could be applied to corridors or even neighborhoods. Macro-level improvements may also be undertaken such as measures to slow vehicle speeds, improve visibility and lighting and others (Zegeer et al 2006, pp 13-17). Other more general methods of identifying unsafe locations such as pedestrian safety audits and tools such as the Pedestrian Intersection Safety Index Tool (and forthcoming user guide, Carter et al., 2006) could also be applied on a city-wide basis in a proactive effort to identify unsafe locations and locations that may be inhibiting pedestrian activity. A forthcoming Roadway Safety Audit specifically for pedestrians is also under development by the Federal Highway Administration.

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[2] One specific problem with the GIS (attributes) data should be noted. When the age variables for 2003 and 2005 data were brought into a database (dbf in the case of 2004-05 data) format to be used in the GIS analyses, the missing age values were converted to 0 and there appear to be no missing age values. Thus, the cases of age = 0 are over-stated. This error did not affect the particular age-related GIS analyses reported on here, where only ages greater than 4 were used, but this problem should be noted or corrected before further age-related analyses are attempted. The age variable and descriptive statistics reported on for the 2001-2005 data do not have this problem.

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Appendix 1. Data codes for Illinois State Crash data files.

Appendix 2. Top 20 Wards ranked by Total (2003 and 2005) Pedestrian Collision Frequency.

Rank	Ward ID	Hall Office	House Number	Ped Crash (2003)	Ped Crash (2005)	Ped Crash (03 & 05)
1	42	121 N LASALLE ST RM 306 60602	121	249	288	537
2	2	121 N LASALLE ST, RM 300 OFFICE 2, 60602	449	146	178	324
3	28	121 N LASALLE ST, RM 203 OFFICE 14, 60602	118	155	131	286
4	17	121 N LASALLE ST RM 209 OFFICE 20 60602	7811	127	104	231
5	6	121 N LASALLE ST, RM 300 OFFICE 9, 60602	406	103	103	206
6	24	121 N LASALLE ST, RM 203 OFFICE 19, 60602	4325	103	96	199
7	1	121 N LASALLE ST, RM 300 OFFICE 5, 60602	1514	90	100	190
8	3	121 N LASALLE ST, RM 300 OFFICE 3, 60602	4645	105	82	187
9	15	121 N LASALLE ST RM 300 OFFICE 26 60602	2440	102	82	184
10	8	121 N LASALLE ST, RM 111, 60602	8539	80	97	177
11	27	121 N LASALLE ST, RM 300 OFFICE 1, 60602	1463	97	79	176
12	20	121 N LASALLE ST, RM 300 OFFICE 19, 60602	5859	82	85	167
13	21	121 N LASALLE ST RM 209 OFFICE 19 60602	909	83	83	166
14	37	121 N. LASALLE ST, RM 300, 60602	5344	94	70	164
15	16	121 N LASALLE ST, RM 300 OFFICE 14, 60602	1249	88	72	160
16	30	121 N LASALLE ST, RM 203 OFFICE 25, 60602	3618	82	64	146
17	31	121 N LASALLE ST, RM 203, 60602	4502	72	71	143
18	5	121 N LASALLE ST, RM 300 OFFICE 23, 60602	1900	66	72	138
18	35	121 N LASALLE ST, RM 209, OFFICE 18	2724	78	60	138
20	34	121 N LASALLE ST, RM 203 OFFICE 8, 60602	507	71	64	135

Appendix 3. Top 20 Wards ranked by Pedestrian Collision Density Index (per mile of roadway).

Rank	Ward ID	Hall Office	House Number	Ped Crash (03 & 05)	Crash Density	Crash Density Index
1	42	121 N LASALLE ST RM 306 60602	121	537	29.49	4.48
2	17	121 N LASALLE ST RM 209 OFFICE 20 60602	7811	231	15.31	2.33
3	15	121 N LASALLE ST RM 300 OFFICE 26 60602	2440	184	13.83	2.10
4	28	121 N LASALLE ST, RM 203 OFFICE 14, 60602	118	286	13.80	2.10
5	48	121 N LASALLE ST, RM 300 OFFICE 13, 60602	5533	103	11.68	1.77
6	37	121 N. LASALLE ST, RM 300, 60602	5344	164	10.07	1.53
7	30	121 N LASALLE ST, RM 203 OFFICE 25, 60602	3618	146	10.04	1.53
8	31	121 N LASALLE ST, RM 203, 60602	4502	143	9.85	1.50
9	16	121 N LASALLE ST, RM 300 OFFICE 14, 60602	1249	160	9.63	1.46
10	35	121 N LASALLE ST, RM 209, OFFICE 18	2724	138	9.55	1.45
11	1	121 N LASALLE ST, RM 300 OFFICE 5, 60602	1514	190	9.30	1.41
12	26	121 N LASALLE ST, RM 300 OFFICE 13, 60602	3236	125	9.27	1.41
13	44	121 N. LASALLE ST, RM 300 OFFICE 14, 60602	1057	112	8.82	1.34
14	2	121 N LASALLE ST, RM 300 OFFICE 2, 60602	449	324	8.59	1.31
15	43	121 N LASALLE ST, RM 209, OFFICE 19	735	133	8.49	1.29
16	49	121 N LASALLE ST, RM 300 OFFICE 24, 60602	7356	85	8.36	1.27
17	46	121 N LASALLE ST, RM 300, 60602	4544	101	8.32	1.26
18	29	121 N LASALLE ST, RM 300, 60602	5941	133	8.22	1.25
19	7	121 N LASALLE ST, RM 207 OFFICE 13, 60602	2522	105	7.83	1.19
20	24	121 N LASALLE ST, RM 203 OFFICE 19, 60602	4325	199	7.61	1.16

Appendix 4. Wards (all) ranked by Collision Frequency - Pedestrians 61 years and older. (Highlighted wards are also in the top 7 wards for crashes involving all ages).

Ward	Frequency	Percent
42	64	10.0
1	29	4.5
2	25	3.9
38	22	3.4
45	20	3.1
6	20	3.1
30	19	3.0
48	19	3.0
11	18	2.8
47	18	2.8
20	17	2.6
39	17	2.6
3	14	2.2
31	14	2.2
35	14	2.2
40	14	2.2
46	14	2.2
50	14	2.2
13	13	2.0
25	13	2.0
8	13	2.0
14	12	1.9
36	12	1.9
49	12	1.9
17	11	1.7
28	11	1.7
15	10	1.6
21	10	1.6
26	10	1.6
32	10	1.6
43	10	1.6
44	10	1.6
24	9	1.4
23	8	1.2
29	8	1.2
33	8	1.2
37	8	1.2
5	8	1.2
10	7	1.1
12	7	1.1
27	7	1.1
16	6	0.9
18	6	0.9
22	6	0.9
4	6	0.9
41	6	0.9
34	4	0.6
7	4	0.6
OUT	3	0.5
19	2	0.3
9	1	0.2
Total	643	100.0

Appendix 5. Intersections with 5 or more pedestrian collisions (2003 and 2005).

Count	INTERSECTION*	BUFFER DIST
13	M L King & 79th	50
11	ASHLAND & 79TH	50
10	CALIFORNIA & NORTH	50
9	CICERO & MADISON	50
8	Pulaski & Irving Park	50
8	KEDZIE & NORTH	50
8	HALSTED & 95TH	50
8	MICHIGAN & MONROE	50
7	CLARK & WASHINGTON	50
7	DEARBORN & RANDOLPH	50
6	CENTRAL & BELMONT	50
6	PULASKI & LAKE	50
6	PULASKI & ROOSEVELT	50
6	CALIFORNIA & 63RD	50
6	WESTERN & ADDISON	50
6	WESTERN & 63RD	50
6	WESTERN & 71ST	50
6	Paulina & 79th	50
6	ASHLAND & 69TH	50
6	Wacker & Madison	50
6	CLARK & DIVISION	50
6	DEARBORN & WASHINGTON	50
6	WABASH & JACKSON	50
6	STATE & 79TH	50
5	AUSTIN & BELMONT	50
5	AUSTIN & CHICAGO	50
5	LARAMIE & CHICAGO	50
5	PULASKI & 26TH	50
5	KIMBALL & BELMONT	50
5	Kimball & 16th	50
5	CALIFORNIA & 55TH	50
5	CALIFORNIA & 71ST	50
5	WESTERN & DEVON	50
5	WESTERN & NORTH	50
5	SOUTHPORT & ADDISON	50
5	SHEFFIELD & WEBSTER	50
5	Halsted & Clark	50
5	HALSTED & 69TH	50
5	WELLS & MONROE	50
5	CLARK & MADISON	50
5	DEARBORN & MADISON	50
5	Dearborn & Jackson	50
5	STATE & MONROE	50
5	STATE & ADAMS	50
5	MICHIGAN & CHICAGO	50
5	MICHIGAN & DELAWARE	50
5	COTTAGE GROVE & 81ST	50
5	JEFFERY & 79TH	50

*Intersection Names in all Caps were joined from Chicago's Intersections shapefile.