

Brief Report: A Demonstration Project Examining Linked EMS-Crash Report Data For Motor Vehicle Crashes Involving Pedestrians & Bicyclists

As part of a larger Governor’s Highway Safety Program (GHSP) funded project to link motor vehicle crash (MVC) and health outcome data, we performed a demonstration project examining the utility of linked North Carolina (NC) Office of Emergency Medical Services (OEMS) and crash reports collected by the NC Division of Motor Vehicles (DMV) for describing the health outcomes of pedestrians and bicyclists involved in MVCs.

The main objectives of this study were to:

- Identify the strengths/limitations of the NC OEMS data for data linkage,
- Identify and describe the methods used to link the NC OEMS and NC DMV data,
- Describe the results of the linked NC OEMS and NC DMV data for pedestrian and bicyclist MVCs, and
- Make recommendations for future data linkages involving NC OEMS and NC DMV data.

Table of Contents

Table of Contents.....	1
Table of Tables	2
Table of Figures.....	2
Strengths/Limitations of NC OEMS Data for Data Linkage	3
EMS Data Linkage.....	3
Data Sources	4
Results: NC OEMS Data	5
Results: NC DMV Crash Report Data	9
Linkage Results	15
Recommendations for Future Data Linkages in NC.....	19
Funding.....	20
Contact Information	20

Table of Tables

TABLE 1: NC OEMS Data Strengths & Limitations..... 3

TABLE 2: EMSPIC Data Linkage Variables 3

TABLE 3: NC OEMS Pedestrian/Bicyclist/Non-Motorized Vehicle Crash Records Stratified by Crash Type 5

TABLE 4: Demographics of NC OEMS Pedestrian/Bicyclist/Non-Motorized Crash Patients..... 6

TABLE 5: Selected Characteristics of NC OEMS Pedestrian/Bicyclist/Non-Motorized Vehicle Crash Patients 8

TABLE 6: Selected Vital Signs of NC OEMS Pedestrian/Bicyclist/Non-Motorized Vehicle Crash Patients..... 9

TABLE 7: NC DMV Pedestrian/Bicyclist Crash Reports Stratified by Crash Type..... 10

TABLE 8: Demographic and other Characteristics of NC DMV Pedestrian/Bicyclist Crash Victims 11

TABLE 9: Selected Characteristics of NC DMV Pedestrian/Bicyclist MVCs..... 13

TABLE 10: Demographic and other Characteristics of NC DMV Motor Vehicle Drivers Involved In Pedestrian/Bicyclist Crashes..... 14

TABLE 11: Results of Linking NC OEMS and NC DMV Crash Report Data 16

TABLE 12: Manual Review of NC OEMS Records with Crash Report ID That Did Not Link to NC DMV Pedestrian/Bicyclist Crash Reports..... 16

TABLE 13: NC OEMS/NC DMV Crash Type Classification ("Linked" Records, Only) 17

TABLE 14: Demographic and other Selected Characteristics of Linked NC OEMS/NC DMV Crash Report Data 18

Table of Figures

FIGURE 1. EMS and Crash Report Records Requested from NC OEMS..... 4

FIGURE 2. EMS Records Obtained from NC OEMS..... 4

FIGURE 3. EMS Records Obtained from NC OEMS and Crash Reports Obtained by UNC HSRC 5

FIGURE 4. Count of Pedestrian/Bicyclist EMS Transports Stratified by Age Group of Crash Patient..... 7

FIGURE 5. Count of Pedestrian/Bicyclist Crash Reports Stratified by Age Group of Crash Victim 12

FIGURE 6. Count of Pedestrian/Bicyclist Crash Reports Stratified by Age Group of Motor Vehicle Driver 15

Strengths/Limitations of NC OEMS Data for Data Linkage

During spring/summer 2017, we held a series of meetings to identify and discuss the positives and negatives of various health outcome data sources for linkage with NC DMV crash report data. We identified the following data sources as suitable candidates for linkage: EMS, emergency department (ED) visit, hospitalization, trauma registry, and mortality data. We selected NC OEMS data as suitable for the demonstration project for the primary reason that the EMS-Performance Improvement Center (EMSPIC) had previously linked two years (2010 and 2011) of EMS data (owned by NC OEMS) to NC DMV crash report data (provided by NC DMV). In addition, we identified the following strengths/limitations of the NC OEMS data (Table One).

TABLE 1: NC OEMS Data Strengths & Limitations	
Strengths	Limitations
Population-based	Previously linked 2010/2011 NC OEMS data are no longer timely
Timely	Data quality problems (e.g. missing data)
Contain variables of public health/research value (e.g. demographic, circumstantial, and clinical information)	Clinical data are based on the primary impression of EMS personnel and do not represent a definitive physician-based diagnosis
Tony Fernandez, Research Director of the EMSPIC, is a member of the Data Linkage Project Staff	Lack of data linkage documentation and expertise (the EMSPIC employee who performed the initial data linkage is longer available to answer questions about methodology)
NC DMV already shares annual crash report data sets with OEMS/EMSPIC	

EMS Data Linkage

The only information that EMSPIC was able to locate describing the methods used for performing the original data linkage was the SAS programming code. Table Two displays the EMS/crash report variables that EMSPIC used to link the two data sources, based on our understanding of the aforementioned SAS code.

TABLE 2: EMSPIC Data Linkage Variables
Date of crash (same date)
Time of crash (+/- 3 hours before or after crash)
Date of birth (two out of three date elements; i.e. day and year OR month and year OR day and month)
Sex (same sex)
County of residence or destination hospital (same county of residence and/or same destination hospital)

Data Sources

Data Requested: We submitted a Data Use Agreement (DUA) to NC OEMS requesting all linked and unlinked EMS and crash report records for pedestrian/bicyclist MVCs for the years 2010-2011. In addition, we requested all non-motorized vehicle crashes captured by EMS in case these records were misclassified pedestrian/bicycle crashes. Figure One displays the data sources that we requested.

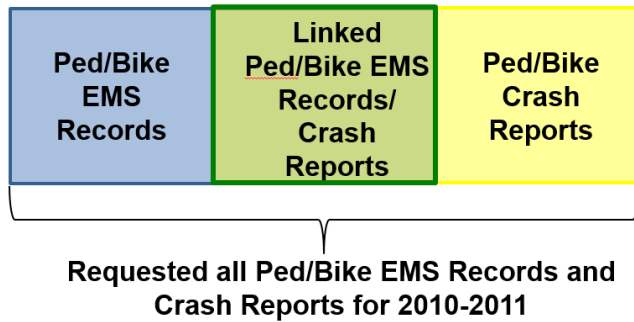


FIGURE 1. EMS and Crash Report Records Requested from NC OEMS

Data Obtained: We obtained a data set containing only the EMS records for pedestrian/bicyclist MVCs (and non-motorized vehicle crashes) with a valid Crash Report ID. Figure Two displays the data source (EMS only) that we obtained from NC OEMS. We were able to obtain the corresponding crash report (based on the Crash Report ID) from the NC Highway Safety Research Center (HSRC). We were able to merge the data sets from the two data sources based on the Crash Report ID. Figure Three displays the data set used in analyses. We were unable to obtain the EMS records for pedestrian/bicyclist MVCs that did not contain a Crash Report ID. This limited our ability to evaluate the data linkage.

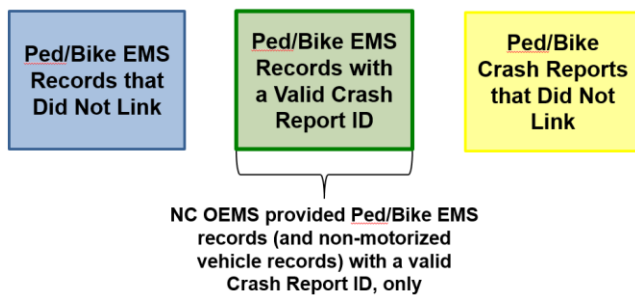


FIGURE 2. EMS Records Obtained from NC OEMS

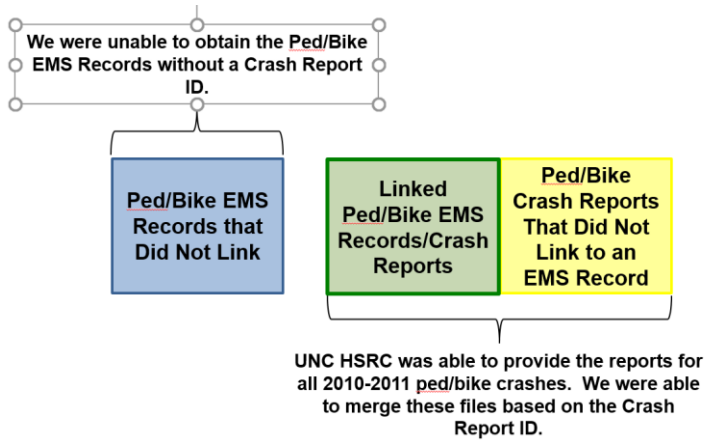


FIGURE 3. EMS Records Obtained from NC OEMS and Crash Reports Obtained by UNC HSRC

Results: NC OEMS Data

Over the two-year period, we obtained a total of 1,130 EMS records for 928 pedestrian MVCs, 184 bicyclist MVCs, and 18 non-motorized vehicle crash records. Over 60% of all records were from 2011 (Table Three).

TABLE 3: NC OEMS Pedestrian/Bicyclist/Non-Motorized Vehicle Crash Records Stratified by Crash Type				
Year, N (%)	EMS Crash Type			TOTAL
	Pedestrian	Bicyclist	Non-Motorized Vehicle¹	
2010	357 (31.6)	73 (6.5)	7 (0.6)	437 (38.7)
2011	571 (50.5)	111 (9.8)	11 (1.0)	693 (61.3)
TOTAL	928 (82.1)	184 (16.3)	18 (1.6)	1,130 (100.0)

¹Non-motorized vehicle crashes were hypothesized to be potential pedestrian/bicycle crashes.

Description of NC OEMS Pedestrian/Bicyclist/Non-Motorized Vehicle Crash Patients

The median age of pedestrian, bicyclist, and non-motorized vehicle crash patients was 32 (interquartile range [IQR]:19-50), 27 (IQR: 18-47), and 41.5 (IQR: 20-51) years of age, respectively. Among all types of crashes, there were more male patients than female. A plurality of crash patients were white (47.9%) and over 90% of patients were of non-Hispanic/Latino ethnicity.

Figure Four displays the counts of pedestrians and bicyclists transported by EMS stratified by age group (counts of non-motorized vehicle crash patients are not displayed). For both crash types, peaks in counts are observed among teenagers and middle-aged adults.

TABLE 4: Demographics of NC OEMS Pedestrian/Bicyclist/Non-Motorized Crash Patients				
Demographic Characteristic, N (%)	EMS Crash Type			TOTAL
	Pedestrian	Bicyclist	Non-Motorized Vehicle	
Sex				
Female	361 (38.9)	26 (14.1)	7 (38.9)	394 (34.9)
Male	567 (61.1)	158 (85.9)	11 (61.1)	736 (65.1)
Total	928	184	18	1,130
Race				
White	416 (47.8)	85 (48.6)	9 (50.0)	510 (47.9)
Black	377 (43.3)	70 (40.0)	7 (38.9)	454 (42.7)
Other Race ¹	78 (9.0)	20 (11.4)	2 (11.1)	100 (9.4)
Total	871	175	18	1,064
Unknown/Missing	57	9	0	66
Hispanic Ethnicity				
Hispanic/Latino	77 (9.1)	10 (6.0)	2 (15.4)	89 (8.7)
Not Hispanic/Latino	767 (90.9)	158 (94.0)	11 (90.9)	936 (91.3)
Total	844	168	13	1,025
Unknown/Missing	84	16	5	105
Age Group (Years)				
0-9	66 (7.1)	11 (6.0)	1 (5.6)	78 (6.9)
10-19	172 (18.6)	47 (25.5)	3 (16.7)	222 (19.7)
20-29	183 (19.7)	44 (23.9)	3 (16.7)	230 (20.4)
30-39	128 (13.8)	19 (10.3)	0 (0.0)	147 (13.0)
40-49	138 (14.9)	27 (14.7)	6 (33.3)	171 (15.1)
50-59	137 (14.8)	23 (12.5)	4 (22.2)	164 (14.5)
60-69	44 (4.7)	12 (6.5)	1 (5.6)	57 (5.0)
70+	59 (6.4)	1 (0.5)	0 (0.0)	60 (5.3)
Total	927	184	18	1,129
Unknown/Missing	1	0	0	1
TOTAL	928 (82.1)	184 (16.3)	18 (1.6)	1,130 (100.0)

¹"Other race" includes: Asian, Native Hawaiian/Pacific Islander, and other race.

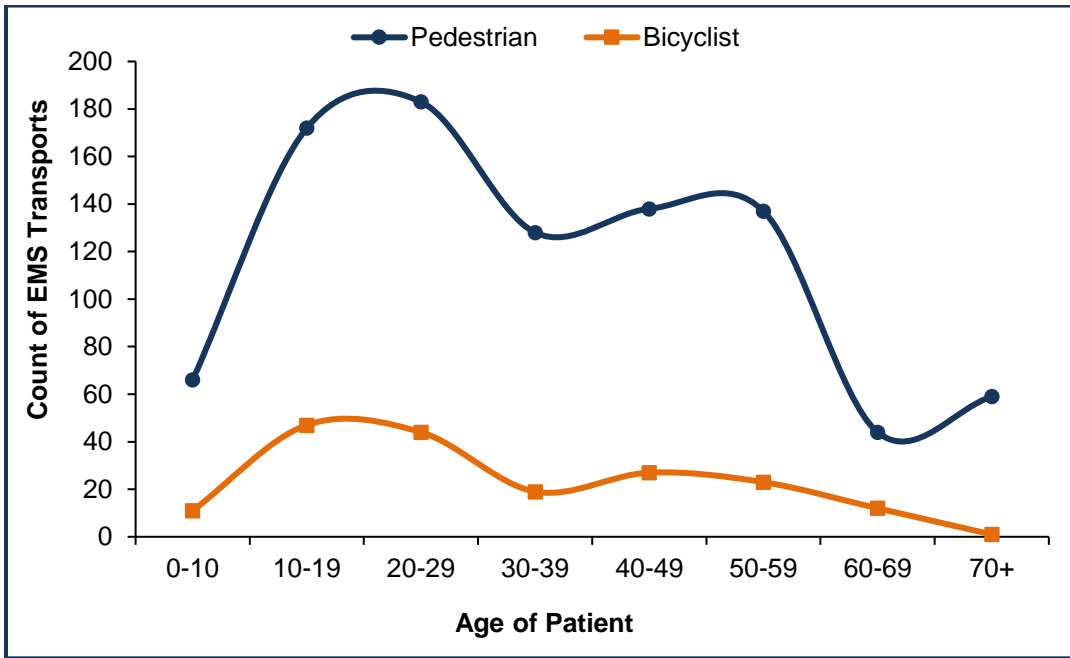


FIGURE 4. Count of Pedestrian/Bicyclist EMS Transports Stratified by Age Group of Crash Patient

Selected Characteristics and Vital Signs of NC OEMS Crash Patients

We identified a number of data elements available in NC OEMS data that contained health outcome information. Tables Five and Six display selected characteristics and vital signs of NC OEMS pedestrian/bicyclist/non-motorized vehicle crash patients, respectively. Across all EMS crash types, the majority (99.5%) of patients had a suspected injury. Most patients had an EMS primary impression of “traumatic injury” (97.5%) and primary symptom of “pain” (58.1%) (Table Five). There was little difference among the three crash types for these two characteristics. In regards to location of injury, bicyclists and victims of non-motorized vehicle crashes were more likely to have injuries to the upper and lower extremities than pedestrians were. On the other-hand, pedestrians were more likely to have a body region labeled as “general/global.” Although data missingness was high for the use of safety equipment, among records with non-missing values, the proportion of bicyclists wearing helmets at the time of the crash was less than 40%. Data missingness was also high for vital signs (Table Six). Among records with non-missing values, over one-half of all crash patients reported moderate or severe pain at the time of transport.

TABLE 5: Selected Characteristics of NC OEMS Pedestrian/Bicyclist/Non-Motorized Vehicle Crash Patients				
Characteristic, N (%)	EMS Crash Type			TOTAL
	Pedestrian	Bicyclist	Non-Motorized Vehicle	
Possible Injury				
Yes	884 (99.8)	166 (98.2)	16 (100.0)	1,066 (99.5)
No	2 (0.2)	3 (1.8)	0 (0.0)	5 (0.5)
Total	886	169	16	1,071
Unknown/Missing	42	15	2	59
Primary Impression				
Traumatic Injury	760 (97.3)	165 (98.2)	11 (100.0)	936 (97.5)
Other Impression ¹	21 (2.7)	3 (1.8)	0 (0.0)	24 (2.5)
Total	781	168	11	960
Unknown/Missing	147	16	7	170
Primary Symptom				
Pain	310 (58.9)	74 (53.6)	9 (69.2)	393 (58.1)
Wound	118 (22.4)	45 (32.6)	3 (23.1)	166 (24.5)
Bleeding	36 (6.8)	8 (5.8)	1 (7.7)	45 (6.6)
Change in Responsiveness	38 (7.2)	6 (4.3)	0 (0.0)	44 (6.5)
Death	10 (1.9)	1 (0.7)	0 (0.0)	11 (1.6)
Other Symptom ²	14 (2.7)	4 (2.9)	0 (0.0)	18 (2.7)
Total	526	138	13	677
Unknown/Missing	402	46	5	453
Body Region				
General/Global	406 (50.1)	68 (38.4)	2 (15.4)	476 (47.6)
Lower Extremity	168 (20.7)	44 (24.9)	4 (30.8)	216 (21.6)
Head	81 (10.0)	18 (10.2)	1 (7.7)	100 (10.0)
Upper Extremity	54 (6.7)	25 (14.1)	5 (38.5)	84 (8.4)
Back	61 (7.5)	14 (7.9)	0 (0.0)	75 (7.5)
Chest/Abdomen	33 (4.1)	5 (2.8)	0 (0.0)	38 (3.8)
Other Region ³	7 (0.9)	3 (1.7)	1 (7.7)	11 (1.1)
Total	810	177	13	1,000
Unknown/Missing	118	7	5	130
Safety Equipment				
Helmet	21 (4.6)	35 (39.8)	0 (0.0)	56 (10.1)
Other Safety Equipment ⁴	27 (5.9)	4 (4.5)	5 (71.4)	36 (6.5)
None	413 (89.6)	49 (55.7)	2 (28.6)	464 (83.5)
Total	461	88	7	556
Unknown/Missing	467	96	11	574
Patient Disposition				
Dead at Scene	10 (1.1)	0 (0.0)	0 (0.0)	10 (0.9)
Treated, Transferred Care	5 (0.5)	2 (1.1)	0 (0.0)	7 (0.6)
Treated, Transported	913 (98.4)	182 (98.9)	18 (100.0)	1,113 (98.5)
Total	928	184	18	1,130
TOTAL	928 (82.1)	184 (16.3)	18 (1.6)	1,130 (100.0)

¹"Other Impression" includes: cardiac arrest, altered level of consciousness, syncope/fainting, hypovolemia/shock, abdominal pain/problems, obvious death, and poisoning/drug ingestion.

²"Other Symptom" includes: breathing problem, malaise, mental/psych, swelling, transport only, and weakness

³"Other Region" includes: neck and genitalia.

⁴"Other Safety Equipment" includes seatbelts, other types of restraints, and protective clothing/gear.

TABLE 6: Selected Vital Signs of NC OEMS Pedestrian/Bicyclist/Non-Motorized Vehicle Crash Patients¹				
Vital Sign, N (%)	EMS Crash Type			TOTAL
	Pedestrian	Bicyclist	Non-Motorized Vehicle	
Total Glasgow Coma Scale				
Mild Brain Injury (13-15)	514 (87.7)	131 (97.8)	17 (100.0)	662 (89.8)
Moderate Brain Injury (9-12)	7 (1.2)	2 (1.5)	0 (0.0)	9 (1.2)
Severe Brain Injury (<9)	65 (11.1)	1 (0.7)	0 (0.0)	66 (9.0)
Total	586	134	17	737
Unknown/Missing	342	50	1	393
Pain Scale				
No Pain (0)	71 (19.7)	14 (15.2)	2 (14.3)	87 (18.7)
Mild Pain (1-3)	54 (15.0)	24 (26.1)	2 (14.3)	80 (17.2)
Moderate Pain (4-6)	87 (24.2)	29 (31.5)	5 (35.7)	121 (26.0)
Severe Pain (7-10)	148 (41.1)	25 (27.2)	5 (35.7)	178 (38.2)
Total	360	92	14	466
Unknown/Missing	568	92	4	664
Simple Triage and Rapid Treatment (START)/Revised Trauma Score				
Delayed (12)	336 (77.4)	92 (83.6)	12 (92.3)	440 (79.0)
Urgent (11)	17 (3.9)	1 (0.9)	0 (0.0)	18 (3.2)
Immediate (3-10)	66 (15.2)	16 (14.5)	1 (7.7)	83 (14.9)
Presumed Dead (0-2)	15 (3.5)	1 (0.9)	0 (0.0)	16 (2.9)
Total	434	110	13	557
Unknown/Missing	494	74	5	573
TOTAL	928 (82.1)	184 (16.3)	18 (1.6)	1,130 (100.0)

¹Based on first recorded measurement.

Results: NC DMV Crash Report Data

Over the two-year period, we obtained 7,267 crash reports for 5,264 pedestrian MVCs and 2,003 bicyclist MVCs. Unlike the NC OEMS data, the number of crashes was distributed nearly evenly over the two years of study (Table Seven).

TABLE 7: NC DMV Pedestrian/Bicyclist Crash Reports Stratified by Crash Type

Year, N (%)	NC DMV Crash Type		TOTAL
	Pedestrian	Bicyclist	
2010	970 (13.3)	2,550 (35.1)	3,520 (48.4)
2011	1,033 (14.2)	2,714 (37.3)	3,747 (51.6)
TOTAL	2,003 (27.6)	5,264 (72.4)	7,267 (100.0)

Description of NC DMV Pedestrian/Bicyclist Crash Victims

The median age of pedestrian and bicyclist crash victims was 32 (IQR: 20-50) and 26 (16-47) years of age, respectively. Table Eight displays demographic and other selected characteristics of pedestrian/bicyclist crash victims. For both pedestrians and bicyclists, there were more male victims than female. Over one-half of crash victims were white (55.4%) and over 90% were of non-Hispanic/Latino ethnicity.

Figure Five displays the counts of pedestrians and bicyclists involved in MVCs stratified by age group. Among bicyclists, a peak in the number of crashes was observed among ten to nineteen year-olds. A peak in the number of pedestrian crashes was observed later in life among 20 to 29 year-olds. Similar to the NC OEMS results, a smaller, secondary peak was observed among pedestrians/bicyclists in early middle age.

In regards to alcohol involvement, a greater proportion of pedestrian crash victims had suspected alcohol involvement as compared to bicyclists. Nearly all pedestrian/bicyclist crash victims had some level of injury (92.3%) (Table Eight).

TABLE 8: Demographic and other Characteristics of NC DMV Pedestrian/Bicyclist Crash Victims

Characteristic, N (%)	NC DMV Crash Type		TOTAL
	Pedestrian	Bicyclist	
Sex			
Female	2,082 (40.1)	285 (14.5)	2,367 (33.1)
Male	3,111 (59.9)	1,677 (85.5)	4,788 (66.9)
Total	5,193	1,962	7,155
Unknown/Missing	71	41	112
Race			
White	2,582 (53.3)	1,129 (61.1)	3,711 (55.4)
Black	2,104 (43.4)	658 (35.6)	2,762 (41.3)
Other Race ¹	159 (3.3)	61 (3.3)	220 (3.3)
Total	4,845	1,848	6,693
Unknown/Missing ²	419	155	574
Hispanic Ethnicity			
Hispanic/Latino	273 (5.3)	101 (5.2)	374 (5.3)
Not Hispanic/Latino	4,845 (94.7)	1,848 (94.8)	6,693 (94.7)
Total	5,118	1,949	7,067
Unknown/Missing	146	54	200
Age Group (Years)			
0-9	314 (6.0)	124 (6.3)	438 (6.1)
10-19	836 (16.1)	482 (24.5)	1,318 (18.4)
20-29	1,164 (22.4)	387 (19.7)	1,551 (21.6)
30-39	807 (15.5)	229 (11.6)	1,036 (14.5)
40-49	822 (15.8)	323 (16.4)	1,145 (16.0)
50-59	658 (12.7)	286 (14.5)	944 (13.2)
60-69	332 (6.4)	103 (5.2)	435 (6.1)
70+	267 (5.1)	33 (1.7)	300 (4.2)
Total	5,200	1,967	7,167
Unknown/Missing	64	36	100
Alcohol Intoxication			
Yes	635 (12.1)	124 (6.3)	759 (10.5)
No	4,612 (87.9)	1,855 (93.7)	6,467 (89.5)
Total	5,247	1,979	7,226
Unknown/Missing	17	24	41
KABCO			
K: Killed	335 (6.6)	41 (2.1)	376 (5.4)
A: Disabling Injury	331 (6.6)	102 (5.3)	433 (6.2)
B: Evident Injury	1,917 (38.0)	853 (44.1)	2,770 (39.7)
C: Possible Injury	2,121 (42.0)	745 (38.5)	2,866 (41.1)
O: No Injury	341 (6.8)	193 (10.0)	534 (7.7)
Total	5,045	1,934	6,979
Unknown/Missing	219	69	288
TOTAL	5,264 (72.4)	2,003 (27.6)	7,267 (100.0)

¹"Other Race" includes: Asian, Native American, and other race.

²"Hispanic Ethnicity" was classified as a category of race; therefore, individuals of Hispanic/Latino ethnicity were classified as unknown race.

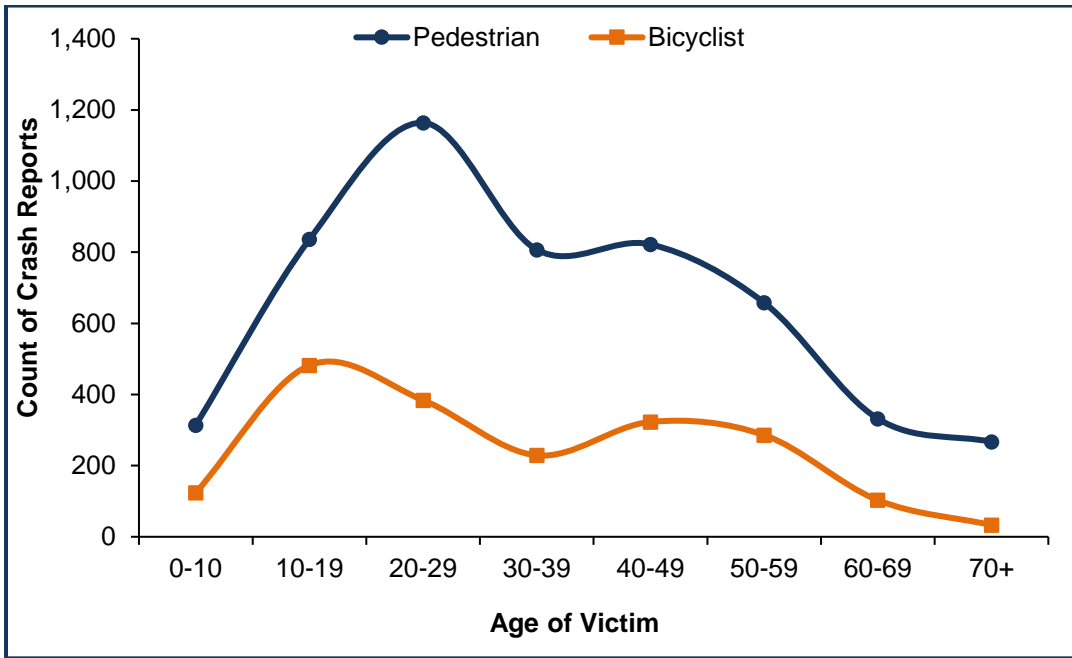


FIGURE 5. Count of Pedestrian/Bicyclist Crash Reports Stratified by Age Group of Crash Victim

NC DMV Pedestrian/Bicyclist Crash Characteristics

NC DMV collects an extensive array of data elements describing the crash victim, vehicle, and event. Table Nine displays selected crash event characteristics for pedestrian/bicyclist crashes. The greatest number of pedestrian/bicyclist crashes occurred in the most populous NC geographic region, the Piedmont; however, a greater proportion of bicyclist crashes occurred in the Coastal Plain than pedestrian crashes. Among pedestrian crashes, most crashes occurred on a local street or in a public vehicular area (e.g. parking lot) while most bicyclist crashes occurred on a local street or on a state secondary road.

TABLE 9: Selected Characteristics of NC DMV Pedestrian/Bicyclist MVCs			
Characteristic of Crash, N (%)	NC DMV Crash Type		TOTAL
	Pedestrian	Bicyclist	
Region of Crash			
Coastal Plain	1,422 (27.1)	677 (33.9)	2,099 (28.9)
Piedmont	3,326 (63.3)	1,186 (59.3)	4,512 (62.2)
Mountain	505 (9.6)	136 (6.8)	641 (8.8)
Total	5,253	1,999	7,252
Unknown/Missing	11	4	15
Urban/Rural Location of Crash			
Urban	3,838 (72.9)	1,404 (70.1)	5,242 (72.1)
Rural	1,426 (27.1)	598 (29.9)	2,024 (27.9)
Total	5,264	2,002	7,266
Unknown/Missing	0	1	1
Weekday/Weekend			
Weekday	3,886 (73.8)	1,537 (76.8)	5,423 (74.6)
Weekend	1,378 (26.2)	465 (23.2)	1,843 (25.4)
Total	5,264	2,002	7,266
Unknown/Missing	0	1	1
Weather Conditions			
Clear	4,187 (79.5)	1,703 (85.0)	5,890 (81.1)
Cloudy	667 (12.7)	228 (11.4)	895 (12.3)
Rain/Frozen Precipitation	377 (7.2)	65 (1.2)	442 (6.1)
Other Weather Conditions ¹	33 (0.6)	7 (0.1)	40 (0.6)
Total	5,264	2,003	7,267
Road Classification			
Local Street	2,523 (47.9)	1,144 (57.6)	3,667 (50.6)
Public Vehicular Area	1,379 (26.2)	132 (6.6)	1,511 (20.8)
State Secondary Route	575 (10.9)	343 (17.3)	918 (12.7)
US Route	287 (5.5)	167 (8.4)	454 (6.3)
NC Route	243 (4.6)	174 (8.8)	417 (5.8)
Private Road, Driveway	166 (3.2)	21 (1.1)	187 (2.6)
Interstate	91 (1.7)	6 (0.3)	97 (1.3)
Total	5,264	1,987	7,251
Unknown/Missing	0	16	16
TOTAL	5,264 (72.4)	2,003 (27.6)	7,267 (100.0)

¹"Other Weather Conditions" Includes fog, smog, smoke, and other weather conditions.

NC DMV Pedestrian/Bicyclist Crash Driver Characteristics

In addition to information about the pedestrian/bicyclist crash victim, NC DMV collects information about the driver of the motor vehicle that struck the victim. Table 10 displays selected characteristics about the MVC driver. Most of the MVCs were low speed crashes of less than 31 miles per hour (67.2%). At the time of the crash, few of the drivers were intoxicated (3.4%). Figure Six displays the number of MVCs stratified by driver age group. Adults 20-29 years of age were involved in the highest number of pedestrian/bicyclist MVCs.

TABLE 10: Demographic and other Characteristics of NC DMV Motor Vehicle Drivers Involved In Pedestrian/Bicyclist Crashes			
Characteristic, N (%)	NC DMV Crash Type		TOTAL
	Pedestrian	Bicyclist	
Driver Sex			
Female	1,959 (45.0)	770 (44.6)	2,729 (44.9)
Male	2,391 (55.0)	956 (55.4)	3,347 (55.1)
Total	4,350	1,726	6,076
Unknown/Missing	914	277	1,191
Driver Age Group (Years)			
0-19	371 (8.6)	118 (6.8)	489 (8.1)
20-29	1,094 (25.2)	395 (22.9)	1,489 (24.6)
30-39	734 (16.9)	303 (17.6)	1,037 (17.1)
40-49	740 (17.1)	314 (18.2)	1,054 (17.4)
50-59	616 (14.2)	276 (16.0)	892 (14.7)
60-69	438 (10.1)	172 (10.0)	610 (10.1)
70+	345 (8.0)	147 (8.5)	492 (8.1)
Total	4,338	1,725	6,063
Unknown/Missing	926	278	1,204
Driver Alcohol Intoxication			
Yes	185 (4.1)	29 (1.6)	214 (3.4)
No	4,321 (95.9)	1,754 (98.4)	6,075 (96.6)
Total	4,506	1,783	6,289
Unknown/Missing	758	220	978
Driver Vehicle Type			
Passenger Car	2,619 (56.2)	1,043 (57.0)	3,662 (56.4)
Sport Utility Vehicle	829 (17.8)	298 (16.3)	1,127 (17.4)
Pickup Truck	667 (14.3)	269 (14.7)	936 (14.4)
Van	290 (6.2)	114 (6.2)	404 (6.2)
Other Truck ¹	158 (3.4)	60 (3.3)	218 (3.4)
Other Vehicle ²	97 (2.1)	45 (2.5)	142 (2.2)
Total	4,660	1,829	6,489
Unknown/Missing	604	174	778
Estimated Driver Speed (MPH)			
0-15	2,488 (50.8)	845 (45.8)	3,333 (49.4)
16-30	806 (16.4)	392 (21.2)	1,198 (17.8)
31-45	1,175 (24.0)	452 (24.5)	1,627 (24.1)
46-60	356 (7.3)	152 (8.2)	508 (7.5)
61-75	66 (1.3)	3 (0.2)	69 (1.0)
76+	10 (0.2)	2 (0.1)	12 (0.2)
Total	4,901	1,846	6,747
Unknown/Missing	363	157	520
TOTAL	5,264 (72.4)	2,003 (27.6)	7,267 (100.0)

Abbreviations: MPH, miles per hour

¹"Other Truck" includes: light truck (mini-van, panel), single unit truck (2-axle, 6-tire), single unit truck (3 or more axles), truck/trailer, tractor/semi-trailer, and unknown heavy truck.

²"Other Vehicle" includes: motorcycle, bus, police vehicle, motor/recreational vehicle, taxicab, and ambulance.

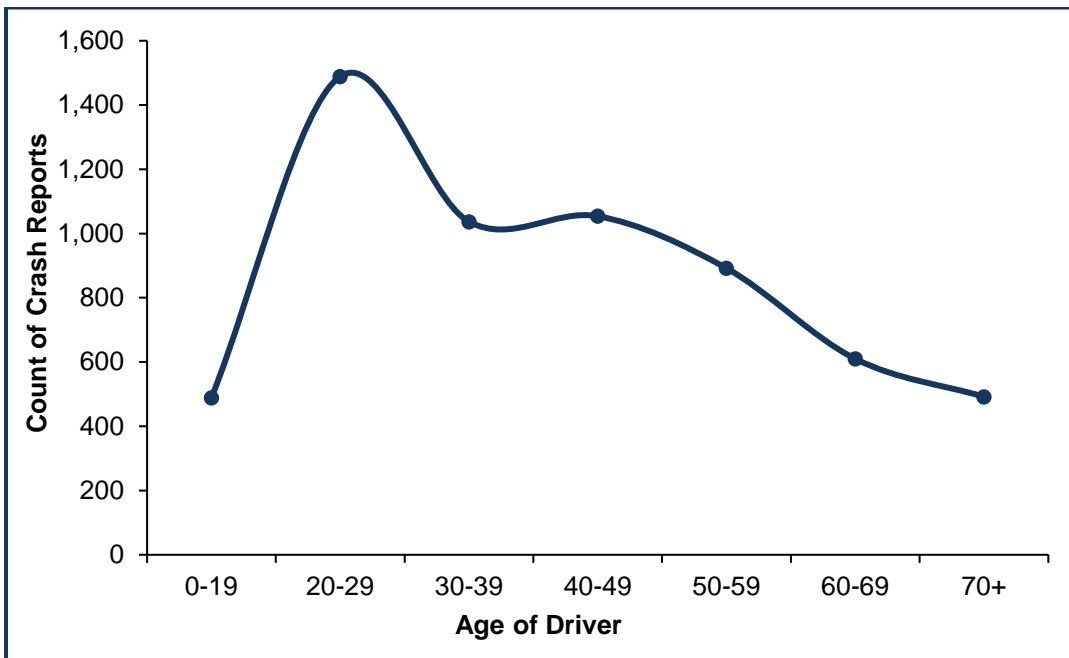


FIGURE 6. Count of Pedestrian/Bicyclist Crash Reports Stratified by Age Group of Motor Vehicle Driver

Linkage Results

Table 11 displays the results of the “linkage” between NC OEMS data and NC DMV crash report data. It is important to note that this table does not display the “true” results of the actual linkage performed by EMSPIC. We received only the EMS records that successfully linked to a crash report. The total number of pedestrian/bicyclist crashes captured by NC OEMS and, therefore, the proportion that did not link is unknown. Due to the limitations of the NC OEMS data provided and the lack of documentation, we could not fully evaluate the linkage.

Despite the limitations of the NC OEMS data, we were able to describe some aspects of the linkage. Of the 7,356 combined EMS records and crash reports, 14.2% “linked”. When we limited the analysis to crash reports in which an ambulance was requested, 20.2% “linked”. Somewhat surprisingly, despite having a valid Crash Report ID, 89 (1.2%) EMS records did not link to the bicyclist/pedestrian crash report in the data set provided by HSRC. Therefore, HSRC provided scanned copies of 87 of the 89 crash records that did not link (two records could not be located in the crash files, based on Crash Report ID provided in the NC OEMS data file). Table 12 displays the results of the manual review of the EMS records/scanned crash reports. Of these 87 records, nearly half involved a misclassification of the type of crash by EMS personnel (e.g., EMS responder described the patient as a “bicyclist” when in actuality the patient was a “motorcyclist”). Another 23.0% involved a misclassification of the crash victim as a pedestrian/bicyclist by law enforcement (LE) personnel (e.g. LE described victim struck while on outside of vehicle as a “MVC occupant” rather than a “pedestrian”). In only 9.2% of the 87 manually reviewed records was there an indication of a “mismatch” (e.g. the records were referring to two different individuals/events).

Table 13 describes the percent agreement between NC OEMS and NC DMV crash type. Overall, there was high percent agreement with over 90% of linked cases receiving the same classification as pedestrian/bicyclist crashes.

Table 14 displays summary statistics of the linked pedestrian/bicyclist NC OEMS/NC DMV crash report data.

TABLE 11: Results of Linking NC OEMS and NC DMV Crash Report Data					
N (%)	Linked Data		Unlinked Data		Total EMS Records/Crash Reports
	EMS/Crash Report¹	EMS	Crash Report		
All Records	1,041 (14.2)	89 (1.2)	6,226 (84.6)		7,356 (100.0)
Crash Reports Where Ambulance was Requested, Only ²	1,040 (20.2)	90 (1.7)	4,013 (78.0)		5,143 (100.0)

¹All EMS records contained a Crash Report ID; however, not all EMS records linked to a NC DMV pedestrian/bicyclist crash report.

²There was one linked record in which an ambulance was not requested and so it was moved to the "unlinked" column.

TABLE 12: Manual Review of NC OEMS Records with Crash Report ID That Did Not Link to NC DMV Pedestrian/Bicyclist Crash Reports				
Determination of Crash Type After Review, N (%)	EMS Crash Type			TOTAL
	Pedestrian	Bicyclist	Non-Motorized Vehicle	
Likely misclassification of crash type by EMS	5 (38.5)	29 (44.6)	9 (100.0)	43 (49.4)
Likely misclassification of crash type by law enforcement officer	3 (23.1)	17 (26.2)	0 (0.0)	20 (23.0)
Likely mismatch during linkage process	2 (15.4)	6 (9.2)	0 (0.0)	8 (9.2)
Other type of misclassification/not enough information	3 (23.1)	14 (21.5)	0 (0.0)	17 (19.5)
Total	13	65	9	87
Missing crash report	0	1	1	2
TOTAL	13 (14.6)	66 (74.2)	10 (11.2)	89 (100.0)

TABLE 13: NC OEMS/NC DMV Crash Type Classification ("Linked" Records, Only)¹			
EMS Crash Type	Crash Report Type		TOTAL
	Pedestrian	Bicyclist	
Pedestrian	791 (76.6)	71 (6.9)	862 (83.4)
Bicyclist	2 (0.2)	169 (16.4)	171 (16.6)
TOTAL	793 (76.8)	240 (23.2)	1,033 (100.0)
Same Classification		960 (92.9)	
Different Classification		73 (7.1)	
TOTAL		1,033 (100.0)	

¹Non-motorized vehicle crashes have been excluded from this table.

TABLE 14: Demographic and other Selected Characteristics of Linked NC OEMS/NC DMV Crash Report Data	
Characteristic, N (%)	Linked EMS Record/Crash Report
Year	
2010	404 (38.8)
2011	637 (61.2)
Total	1,041
KABCO	
K: Killed	65 (6.4)
A: Disabling Injury	94 (9.2)
B: Evident Injury	523 (51.1)
C: Possible Injury	327 (32.0)
O: No Injury	14 (1.4)
Total	1,023
Unknown/Missing	18
Sex	
Female	356 (34.4)
Male	680 (65.6)
Total	1,036
Unknown/Missing	5
Age Group (Years)	
0-9	69 (6.7)
10-19	207 (20.0)
20-29	216 (20.8)
30-39	140 (13.5)
40-49	155 (15.0)
50-59	142 (13.7)
60-69	53 (5.1)
70+	54 (5.2)
Total	1,036
Unknown/Missing	5
Time of Crash	
12:00 - 5:59 AM	81 (7.8)
6:00 - 11:59 AM	220 (21.1)
12:00 - 5:59 PM	387 (37.2)
6:00 - 11:59 PM	353 (33.9)
Total	1,040
Unknown/Missing	1
Season¹	
Winter	226 (21.7)
Spring	251 (24.1)
Summer	231 (22.2)
Fall	333 (32.0)
Total	1,041
Possible Injury (EMS)	
Yes	985 (99.7)

TABLE 14: Demographic and other Selected Characteristics of Linked NC OEMS/NC DMV Crash Report Data	
Characteristic, N (%)	Linked EMS Record/Crash Report
No	3 (0.3)
Total	988
Unknown/Missing	53
Patient Disposition (EMS)	
Dead at Scene	10 (1.0)
Treated, Transferred Care	5 (0.5)
Treated, Transported by EMS	1,026 (98.6)
Total	1,041
TOTAL	1,041

¹Winter: December, January, February; Spring: March, April, May; Summer: June, July, August; and Fall: September, October, November

Recommendations for Future Data Linkages in NC

Unfortunately, we were unable to fully evaluate the data linkage because:

1) We did not have any information about the pedestrian/bicyclist crashes captured by NC OEMS that did not link to a crash report;

2) We lacked documentation about the methodology and reasoning behind the initial linkage performed by EMSPIC;

3) And our linkage results were poor. However, we have the following recommendations for future data linkages.

1. Thoroughly document the methods used to perform data linkage.

Rationale: Documentation is extremely important for the purposes of evaluation and for informing others about the process used to link the data, including the rationale behind methodologic decisions. This is especially true when the personnel used to perform the linkage are no longer available to provide input.

2. Include age as a linkage variable (in addition to date of birth) when performing data linkage using NC DMV crash report data.

Rationale: Upon reviewing the crash reports of pedestrian/bicyclist crashes, we learned that date of birth is often missing for these individuals (as well as for motor vehicle passengers, particularly children). Therefore, we recommend that age be included in the linkage methodology to account for crash victims for whom date of birth is missing. In addition, we learned that calculated age could vary slightly between data sets. To mitigate this problem, we recommend the use of age brackets (e.g. +/- two years).

3. Improve quality of health outcome data captured by NC OEMS.

Rationale: We found that NC OEMS did not capture as many health outcome data elements as we had hoped. In addition, among the health outcome data elements captured by NC OEMS, data missingness was high and/or the data element contained vague or unhelpful information. We feel that these elements could be improved through education of EMS personnel or through changes to the software used to collect these data elements. We recommend waiting to perform an on-going statewide linkage between NC OEMS and NC DMV crash report data until NC OEMS data improve in this regard.

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Contact Information

If you have any questions about this report, please contact:

Anna Waller, ScD
Principle Investigator
Carolina Center for Health Informatics
Department of Emergency Medicine, University of North Carolina at Chapel Hill
100 Market Street
Chapel Hill, NC 27516
awaller@med.unc.edu