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Characteristics of Law Enforcement Officers' Fatalities in Motor Vehicle Crashes

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16. Abstract

The Law Enforcement Officers Killed & Assaulted (LEOKA) data is collected and published annually by the Federal Bureau of Investigation to provide information on the law enforcement officers who were killed feloniously or accidentally as well as of those who were assaulted while performing their duties. The LEOKA data shows that the number of law enforcement officers killed in the line of duty by violent means dominated those who were killed in motor vehicle crashes until the middle of the 1990s. However, the recent trend shows that motor vehicle crashes have become the major cause of fatalities of law enforcement officers. These observations suggested an in-depth analysis of the data.

The Fatality Analysis Reporting System (FARS) is maintained by National Highway Traffic Safety Administration. The FARS is currently the only database that contains detailed information on the fatal crashes involving law enforcement officers. The characteristics of law enforcement officers' fatalities in motor vehicle traffic crashes were investigated using the FARS data from 1980 to 2008. The characteristics were analyzed at the crash level for 772 crashes that involved at least one law enforcement officer's fatality, at the vehicle level for 776 police vehicles with law enforcement officers' fatalities, and at the person level for 823 law enforcement officers killed in motor vehicle crashes.

The characteristics of fatalities in passenger vehicle crashes were compared between the law enforcement officer (LEO) and non-LEO groups using the FARS data from 2000 to 2008. The LEO and non-LEO groups show substantially different characteristics at crash time, first harmful event, roadway function class (rural/urban), emergency use, fire occurrence, rollover, most harmful event, impact point, vehicle maneuver, crash avoidance maneuver, age, sex, person type, seating position, restraint use, and air bag availability and deployment.

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Table of Contents

Executive Summary

The Law Enforcement Officers Killed & Assaulted (LEOKA) data, compiled by the Federal Bureau of Investigation, shows that the number of law enforcement officers (LEOs) killed in the line of duty by violent means dominated those who were killed in motor vehicle crashes until the middle of the 1990s. However, the recent trend shows that motor vehicle crashes have become the major cause of fatality of law enforcement officers. These observations suggested an in-depth analysis of the data.

The Fatality Analysis Reporting System (FARS) is currently the only database that contains detailed information on the fatal crashes that involved law enforcement officers. The characteristics of law enforcement officers' fatalities in motor vehicle crashes were investigated using the FARS data from 1980 to 2008. The statistical analysis of the data found several important characteristics of the law enforcement officers' fatalities.

- **Regional Distribution**

  California recorded the highest number of LEO fatalities in motor vehicle crashes (107, 13.0%), followed by Texas (81, 9.8%), Georgia (43, 5.2%), New York (39, 4.7%), Alabama (36, 4.4%), Florida (35, 4.3%), and Tennessee (33, 4.0%).

- **Crash Level**

  The crashes with LEO fatalities in passenger vehicles occurred more frequently during dark hours (8 p.m. to 4:59 a.m.), while the crashes with LEO fatalities on motorcycles occurred mostly during the daylight hours from noon to 3:59 p.m.

  In FARS, the first harmful event is defined as the first property damage (including to vehicles) or injury producing crash event. The first harmful event data of the crashes with LEO fatalities in passenger vehicles shows that "collision[s] with motor vehicle in-transport" decreased from 60 percent in the 1980s to 52 percent in the 1990s and to 48 percent in the 2000s. On the contrary, "collision[s] with fixed object" such as boulder, guardrail, traffic barrier, etc., increased from 29 percent to 37 and then to 41 percent, respectively, in these three time periods. Rollovers remained around 5 percent over the entire time period.

  The FARS data on the manner of collision with a motor vehicle in-transport shows that more than half of the passenger vehicle crashes resulting in LEO fatalities were angle crashes (55%) followed by head-on crashes (27%), rear-end crashes (13%), and sideswipe crashes (5%). Motorcycle crashes with LEO fatalities had mostly angle collisions (67%). Both head-on and rear-end collisions each accounted for 13 percent and sideswipe 8 percent.

  Fifty-four percent of the passenger vehicle crashes with LEO fatalities occurred on rural areas and 46 percent on urban areas. However, 89 percent of the motorcycle crashes with LEO fatalities occurred on roadways in urban areas and only 11 percent occurred on roadways in rural areas.

- **Vehicle Level**

  Rollover as a subsequent event accounted for 17 percent of the police passenger vehicles involving LEO fatalities in the 1980s. However, it increased to 20 percent in the 1990s and to 26 percent in the 2000s. As a result, rollover in total increased from 21 percent in the 1980s to 27 percent in the 1990s and then to 31 percent in the 2000s.

  Forty-seven percent of the police passenger vehicles involving LEO fatalities had "front" as the initial impact point, 24 percent had "left side," 13 percent had "right side," and 7 percent had "rear." On the other hand, almost three-fourths (73%) of the initial impact point of the police motorcycles involving LEO fatalities were "front."

  "Going straight" (61%) was the major vehicle maneuver type for the police passenger vehicles involving LEO fatalities. This is followed by "negotiating curve" (19%) and "maneuvering to avoid animal/pedestrian/object" (6%). In the case of motorcycles, "going straight" (71%) is followed by "passing/overtaking another vehicle" (11%) and "negotiating curve" (8%).

  Drivers of 37 percent of the police passenger vehicles and 29 percent of the police motorcycles involving LEO fatalities did not attempt to avoid the crashes. In attempting to avoid the crashes, 13 percent of the police passenger vehicle drivers used steering; 6 percent used braking; and 10 percent used steering as well as braking. On the other hand, 19 percent of the police motorcycle drivers used braking; 9 percent used steering; and 14 percent used both steering and braking.

- **Person Level**

  Of the law enforcement officers killed in passenger vehicle crashes, 28 percent used restraint systems in the 1980s. The restraint system use increased to 56 percent in the 1990s, which is a 28-percentage-point increase. Recent data shows that the restraint system use decreased to 50 percent.

  Air bags were deployed in 56 percent of the LEO fatalities in passenger vehicles in the 2000s, which is a 29-percentage-point increase from 27 percent in the 1990s.

  During the period from 1980 to 2008, 19 percent of law enforcement officers killed in passenger vehicle crashes were ejected from the vehicles (15% totally ejected and 4% partially ejected).

The characteristics of fatalities in passenger vehicle crashes were compared between the LEO and non-LEO groups using the FARS data. During the period from 2000 to 2008, the LEO and non-LEO group show substantially different characteristics at crash time, first harmful event, roadway function class (rural/urban), roadway surface condition, emergency use, fire occurrence, rollover, most harmful event, impact point, vehicle maneuver, crash avoidance maneuver, age, sex, person type, seating position, restraint use, and air bag availability and deployment.

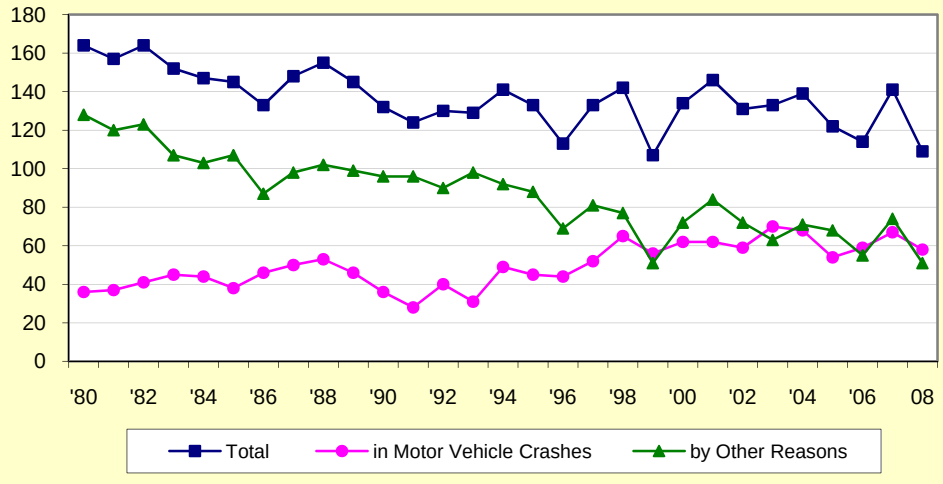
1. Introduction

The information on the law enforcement officers killed in the line of duty have been collected and published annually by the Federal Bureau of Investigation since 1937 [1]. The FBI began to publish two reports, "Law Enforcement Officers Killed Summary" and "Analysis of Assaults on Federal Officers" in 1972. Since 1982, these two reports were combined into the annual publication, "Law Enforcement Officers Killed & Assaulted" (LEOKA).

The LEOKA data is provided to law enforcement agencies throughout the United States. This data is analyzed for better understanding of the circumstances surrounding these fatalities and assaults, and is used for training purposes to create more realistic scenarios.

Figure 1 shows the time series of the number of law enforcement officers killed in the line of duty from the LEOKA data over the period of 29 years (1980-2008). The total number of law enforcement officers killed shows a downward trend until the end of the 1990s and maintains a slight upward level since 2000. The reason for this trend lies in the fact that the law enforcement officers killed in motor vehicle crashes have increased since the end of the 1990s, while the law enforcement officers killed by other violent means have steadily decreased during the entire period.

Figure 1: Number of Law Enforcement Officers Killed



Source: LEOKA data, FBI, 1980-2008

This fact is clearly demonstrated in Table 1. On average, 151 law enforcement officers were killed every year in the 1980s, which declined to an average of 128 in 1990s and rose slightly to 130 in the 2000s. The average number of law enforcement officers killed in motor vehicle crashes was 44 in the 1980s and 45 in the 1990s, but jumped up to 62 in the 2000s. On the other hand, the average number of law enforcement officers killed by

the other reasons decreased from 107 in the 1980s to 84 in the 1990s and then to 68 in the 2000s.

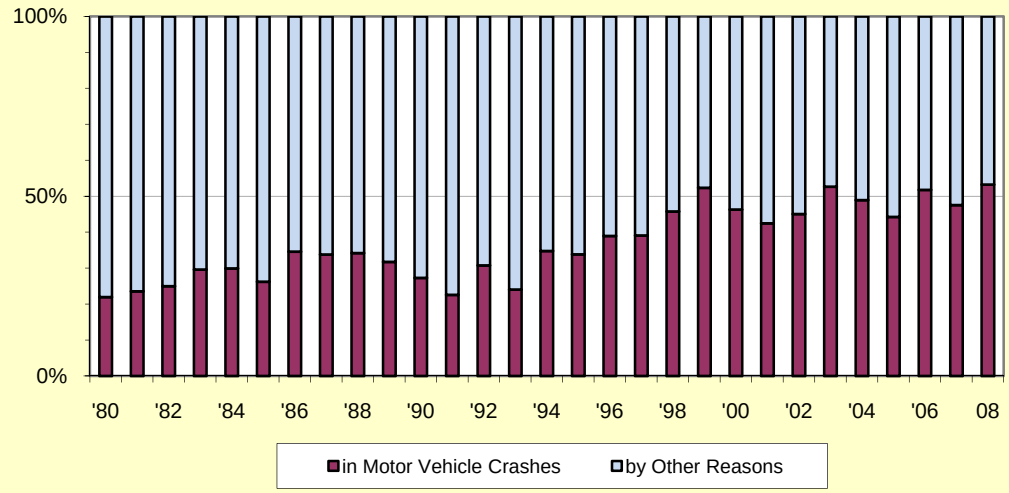
Table 1: Number of Law Enforcement Officers Killed in the Line of Duty

	Time Period			Total
	1980-1989	1990-1999	2000-2008	1980-2008
In Motor Vehicle Crashes	436	446	559	1,441
By Other Reasons	1,074	838	610	2,522
Total	1,510	1,284	1,169	3,963

Source: LEOKA data, FBI, 1980-2008

These trends are also reflected in terms of the proportion of law enforcement officers killed in motor vehicle crashes to the total law enforcement officers killed as shown in Figure 2. The law enforcement officers killed in motor vehicle crashes accounted for only 29 percent of the total law enforcement officers killed in the 1980s, but increased to 35 percent in the 1990s and 48 percent in the 2000s. Recently, the law enforcement officers killed in motor vehicle crashes have exceeded 50 percent – 52 percent in 1999, 53 percent in 2003, 52 percent in 2006, and 53 percent in 2008.

Figure 2: Percentage of Law Enforcement Officers Killed

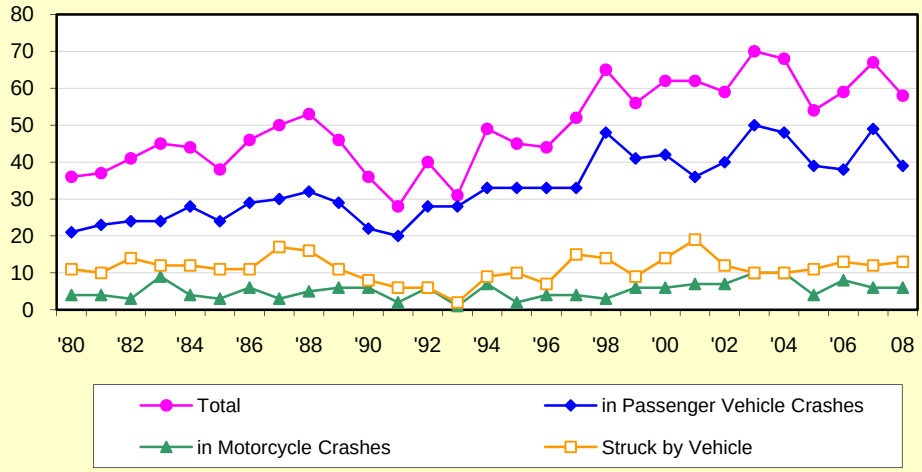


Source: LEOKA data, FBI, 1980-2008

Figure 3 shows a breakdown of the number of law enforcement officers killed in motor vehicle crashes by passenger vehicle crashes, motorcycle crashes, and struck by vehicle. The number of law enforcement officers killed in motorcycle crashes or struck by vehicle has been stable during the entire period, whereas the number of law enforcement officers

killed in passenger vehicle crashes has increased since the end of the 1990s. Thus, the increase in the number of law enforcement officers killed in motor vehicle crashes is mainly due to the increase in the number of passenger vehicle crashes.

Figure 3: Number of Law Enforcement Officers Killed In Motor Vehicle Crashes



Source: LEOKA data, FBI, 1980-2007

Recapitulating the trend analyses from the LEOKA data (Figure 1, 2, and 3), the law enforcement officers killed in the line of duty by the violent means dominated those who were killed in motor vehicle crashes until the middle of the 1990s. However, the recent trend shows that motor vehicle crashes have become the major cause of fatality of law enforcement officers. These observations suggested the need for an in-depth analysis of the data. The LEOKA data provides only the total number of law enforcement officers killed in motor vehicle crashes. Therefore, the other data such as the FARS is used as well in order to analyze the specific circumstances of the motor vehicle crashes that involved LEO fatalities. Bean and Noh [2] analyzed the FARS data from 1996 to 2007 to study the LEO fatalities in motor vehicle crashes. The present study provides detailed analysis of the characteristics of the LEO fatalities as well as the comparison of the LEO and non-LEO fatalities.

2. Law Enforcement Officer Fatalities in FARS Data

FARS data is maintained by NHTSA and contains a census of fatal traffic crashes within the 50 States, the District of Columbia, Puerto Rico, and the Virgin Islands. The FARS is currently the only database that contains detailed information on fatal crashes involving law enforcement officers.

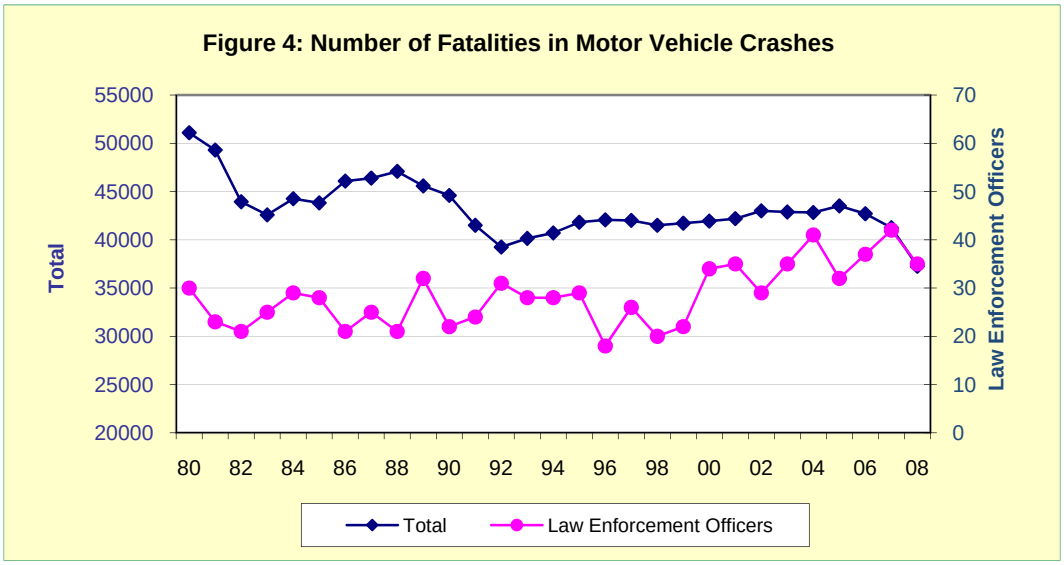
In the FARS data, a police vehicle refers to a readily identifiable (by lights or marking) vehicle that is owned by any local, county, State, or Federal police agency [3, 4]. The vehicles are presumed to be in special police use at all times. Personal vehicles not owned by the agency but used by officers or agents (e.g., undercover) do not fall into the category. The FARS data only discerns police vehicles and does not contain any information indicating whether a person in the database is a member of law enforcement or not.

In this study, a LEO fatality in a motor vehicle crash refers to an occupant fatality in a police vehicle in the FARS data. A law enforcement officer who was killed in a non-police vehicle or as a pedestrian was not counted as a fatality in this data group. On the other hand, an occupant who was killed in a police vehicle but was not a law enforcement officer is counted as a LEO fatality. The number in this latter category is presumed to be very small.

Note that the FARS data has a smaller number of LEO fatalities in motor vehicle crashes than the number in the LEOKA data due to the following reasons.

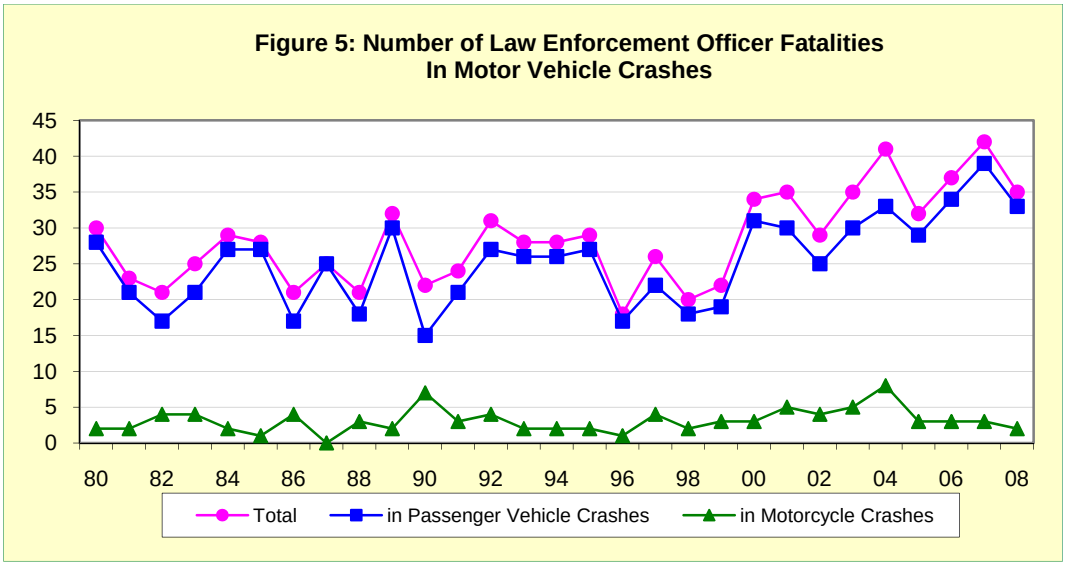
- There are definitional differences between the two databases in describing a police vehicle.
- The FARS data has a requirement that the fatality must occur within 30 days of the crash, while the LEOKA does not have such a requirement.
- The FARS data depends on the State data filing requirements, while the LEOKA does not.

Figure 4 shows the number of LEO fatalities in motor vehicle crashes along with the total number of fatalities in the FARS data from 1980 to 2008. The number of LEO fatalities was stable during the 1980s and 1990s, while it has been increasing since 2000. This trend is similar to the one observed in the LEOKA data as shown in Figure 1.



Source: FARS, NCSA, 1980-2008

As depicted in Figure 5, the FARS data also shows that the increase in the number of LEO fatalities in passenger vehicles has lead to an increase in the total number of LEO fatalities in motor vehicle crashes since 2000. However, the number of LEO fatalities in motorcycle crashes in FARS has not changed substantially during the period from 1980 to 2008. This is in agreement with the result from the LEOKA data (Figure 3).



Source: FARS, NCSA, 1980-2008

Even though the numbers of LEO fatalities in motor vehicle crashes are different in the FARS and LEOKA data, both data sets show similar trends as explained above.

Therefore, this study investigated the FARS data in order to provide more specific characteristics of LEO fatalities in motor vehicle crashes that were motivated by the trend analysis of the LEOKA data.

Prior to a discussion on the characteristics of LEO fatalities at crash, vehicle, and person levels, the summary statistics of the crashes that involve at least one LEO fatality are an appraisal of the overall situation in the United States. Also, the regional distribution of LEO fatalities is discussed in detail.

2.1 Summary Statistics of Law Enforcement Officer Fatalities

A total of 772 crashes involved at least one LEO fatality from 1980 to 2008. Of these, 682 crashes had LEO fatalities in passenger vehicles and 90 crashes had LEO fatalities on motorcycles.

These 772 crashes involved 776 police vehicles that had at least one LEO fatality and 28 police vehicles that had no LEO fatality. The crashes with LEO fatalities also involved 525 non-police vehicles, of which 71 vehicles had occupant fatalities and 454 vehicles had no occupant fatality.

During the period from 1980 to 2008, a total of 823 law enforcement officers were killed, of which 733 were in passenger vehicles and 90 were on motorcycles. Note that the LEOs struck by vehicles were not included. In addition, the crashes with LEO fatalities resulted in fatalities of 91 people who were not themselves law enforcement officers.

Table 2: Number of Crashes, Vehicles, and Fatalities Involved In the Motor Vehicle Crashes With Law Enforcement Officer Fatalities

	Time Period			Total
	1980-1989	1990-1999	2000-2008	1980-2008
Crashes With LEO Fatalities	**231**	**233**	**308**	**772**
in Passenger Vehicle	207	203	272	682
on Motorcycle	24	30	36	90
Police Vehicles With LEO Fatalities	**233**	**233**	**310**	**776**
Passenger Vehicle	209	203	274	686
Motorcycle	24	30	36	90
Police Vehicle Without LEO Fatalities	8	8	12	28
Non-Police Vehicle With Occupant Fatalities	22	23	26	71
Non-Police Vehicle Without Occupant Fatalities	145	137	172	454
LEO Fatalities	**255**	**248**	**320**	**823**
in Passenger Vehicle	231	218	284	733
on Motorcycle	24	30	36	90
Non-LEO fatalities	27	28	36	91

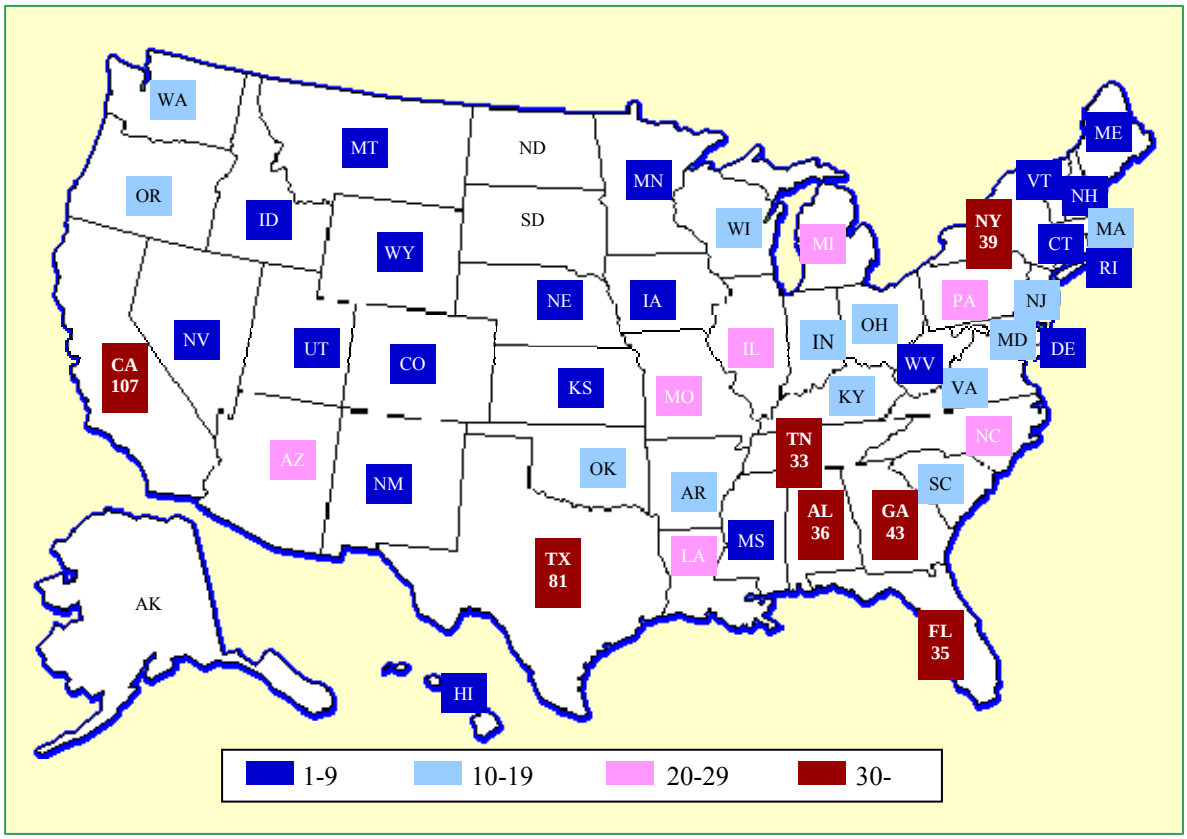
Source: FARS data, NCSA, 1980-2008

As indicated by the trend analysis in Figure 4, the number of LEO fatalities has increased since 2000. On average, 36 law enforcement officers were killed every year in motor vehicle crashes during the period from 2000 to 2008, which is a 44-percentage-point increase from the average of 25 LEO fatalities during the period from 1980 to1999.

2.2 Regional Distribution of Law Enforcement Officer Fatalities

Figure 6 presents the number of LEO fatalities in motor vehicle crashes in the United States from 1980 to 2008. California recorded the highest number (107, 13.0%) of LEO fatalities followed by Texas (81, 9.8%), Georgia (43, 5.2%), New York (39, 4.7%), Alabama (36, 4.4%), Florida (35, 4.3%), and Tennessee (33, 4.0%).

Figure 6: Number of Law Enforcement Officer Fatalities in Motor Vehicle Crashes, by State

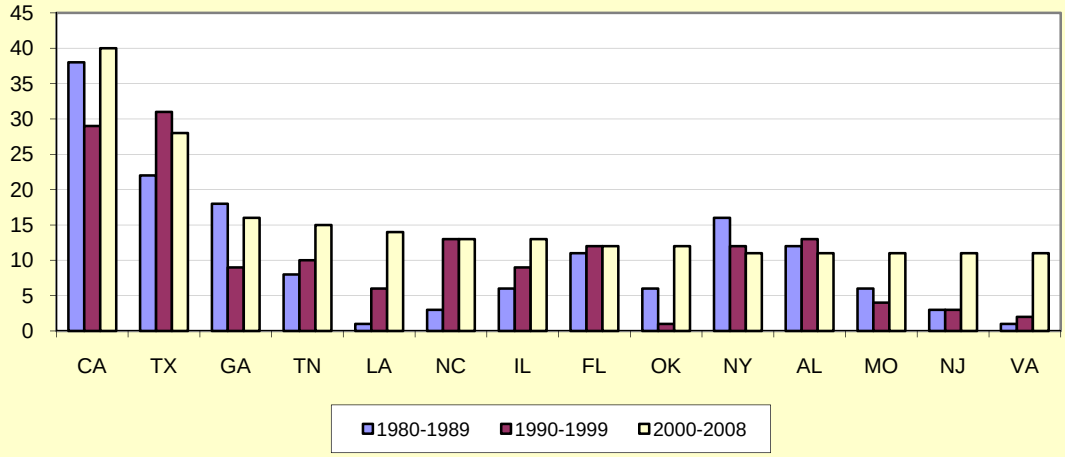


Source: FARS, NCSA, 1980-2008

Figure 7 shows the number of LEO fatalities by the three time periods 1980-1989, 1990-1999, and 2000-2008 for the 14 States that have more than 10 LEO fatalities during the period from 2000 to 2008. (See Table A of the Appendix, Number of Law Enforcement Officer Fatalities in Motor Vehicle Crashes, by States.) California and Texas have the highest level of LEO fatalities over all these periods. The number of LEO fatalities shows

an increasing trend in Tennessee, Louisiana, North Carolina, Illinois, Oklahoma, Missouri, New Jersey, and Virginia. On the other hand, the number of LEO fatalities has decreased gradually in New York.

Figure 7: Number of Law Enforcement Officer Fatalities In Motor Vehicle Crashes, by State[1]



[1] These States have more than 10 LEO fatalities during the period of 2000 to 2008 and are sorted by those numbers.
Source: FARS, NCSA, 1980-2008

3. Characteristics of Law Enforcement Officer Fatalities in Motor Vehicle Crashes

This section investigates the characteristics of LEO fatalities in motor vehicle crashes using the FARS data from 1980 to 2008. The characteristics were analyzed at the crash level for 772 crashes that involved at least one LEO fatality, at the vehicle level for 776 police vehicles with LEO fatalities, and at the person level for 823 LEO fatalities.

The data on passenger vehicles and on motorcycles was analyzed separately as their characteristics are different. The passenger vehicle cases for each level (crashes, vehicles, and persons) were analyzed for the three time periods: 1980-1989, 1990-1999, and 2000-2008 whenever they showed substantial differences along the time periods. On the other hand, the motorcycle cases were analyzed for the entire period because the number of such cases in each of the above three time periods is small.

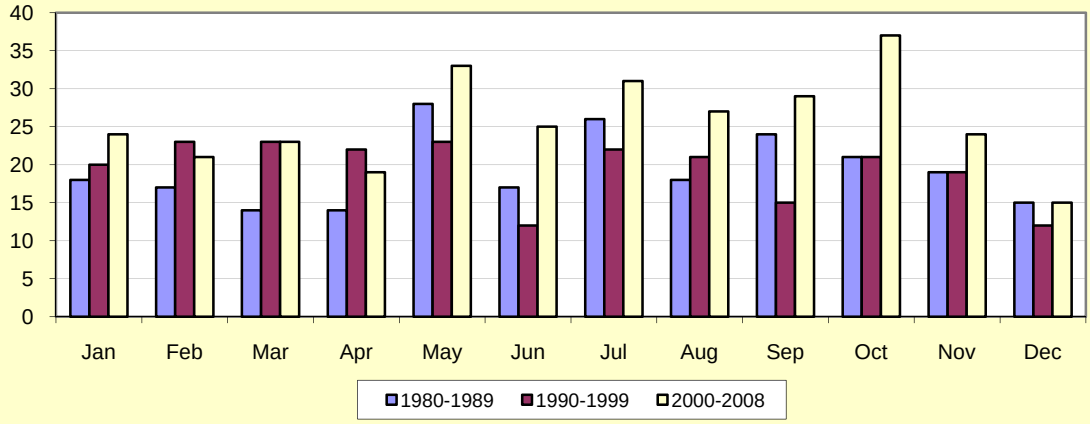
3.1 Characteristics at Crash Level

Month of the Crash

The monthly frequency distributions of the motor vehicle crashes with LEO fatalities are shown in Figure 8. The frequencies of crashes shown as bars in this figure are listed in Table B of the Appendix. For all the years (1980-2008), May recorded the highest number (84, 11%) of crashes. This is followed by July and October, which both have 79 crashes (10%). The lowest number of crashes (42, 5%) was recorded in December.

A total of 308 motor vehicle crashes with LEO fatalities occurred during the period 2000-2008. Of these, 182 crashes (59%) occurred in the consecutive six months from May to October with the highest number 37 (12%) in October, while 126 crashes (41%) occurred in the other six months from November to April.

Figure 8: Number of Motor Vehicle Crashes With Law Enforcement Officer Fatalities, by Month

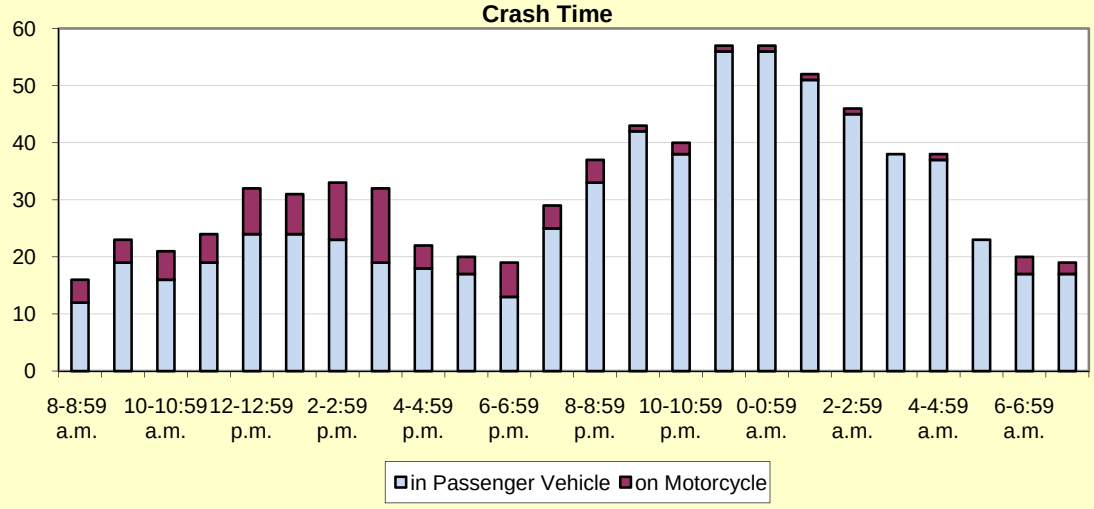


Source: FARS, NCSA, 1980-2008

Crash Time

As shown in Figure 9, the pattern of the hourly distribution of the crashes with LEO fatalities in passenger vehicles is opposite to the pattern shown by the crashes involving motorcycles. The crashes with LEO fatalities in passenger vehicles occurred more frequently during dark hours (8 p.m. to 4:59 a.m.) with maximum at midnight (11 p.m. to 1:59 a.m.). On the other hand, the crashes with LEO fatalities on motorcycles occurred mostly during daylight hours from noon to 3:59 p.m. The number of crashes by crash time in Figure 6 is listed in Table C of the Appendix.

Figure 9: Number of Crashes With Law Enforcement Officer Fatalities, by Crash Time



Source: FARS, NCSA, 1980-2008

The pattern shown by the number of crashes over the three work shifts[1]: 8 a.m.-3:59 p.m., 4 p.m.-11:59 p.m., and midnight-7:59 a.m. is also opposite to the pattern shown by the crashes involving motorcycles as shown in Table 3. The crashes with LEO fatalities in passenger vehicles occurred mostly (42%) during the midnight-7:59 a.m. shift followed by 4 p.m.-11:59 p.m. shift (36%) and 8 a.m.-3:59 p.m. shift (23%). On the contrary, 62 percent of the crashes with LEO fatalities on motorcycles occurred during the 8 a.m.-3:59 p.m. shift, 28 percent during the 4 p.m.-11:59 p.m. shift, and only 10 percents during the midnight-7:59 a.m. shift.

[1] Typically law enforcement agencies have these three work shifts. But some agencies have different work shifts. The number of crashes by other work shifts can be calculated from the number of crashes with LEO fatalities by crash time in Table C of Appendix.

Table 3: Crashes With Law Enforcement Officer Fatalities, by Work Shift						
	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
Work Shift						
8 a.m.-3:59 p.m.	156	22.9%	56	62.2%	212	27.5%
4 p.m.-11:59 p.m.	242	35.5%	25	27.8%	267	34.6%
Midnight-7: 59 a.m.	284	41.6%	9	10.0%	293	38.0%
Total	682	100.0%	90	100.0%	772	100.0%
Source: FARS, NCSA, 1980-2008						

First Harmful Event and Manner of Collision

The "first harmful event" in FARS terminology is defined as the first property damage (including to vehicles) or injury-producing event.

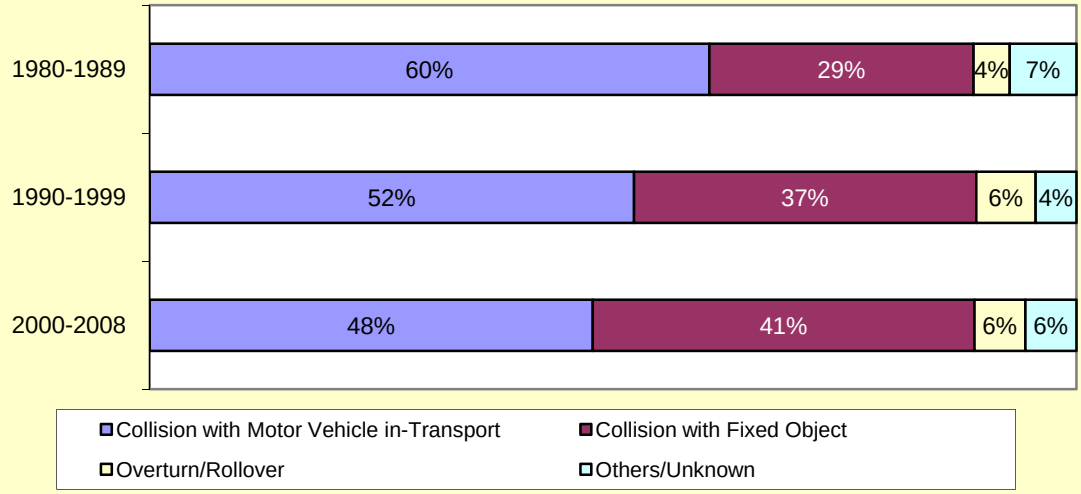
As shown in Table 4, "collision with motor vehicle in-transport" accounted for 53 percent of the crashes with LEO fatalities in passenger vehicles, followed by "collision with fixed object" (36%), and "rollover" (5%). In the case of the crashes with LEO fatalities on motorcycles, "collision with motor vehicle in-transport" (80%), and "rollover" (9%) were much higher compared to those of the passenger vehicle crashes, while "collision with fixed object (10%)" was much lower.

Table 4: Crashes With Law Enforcement Officer Fatalities, By First Harmful Event and Manner of Collision						
	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
First Harmful Event						
Collision With Motor Vehicle in-Transport	361	52.9%	72	80.0%	433	56.1%
Collision With Fixed Object	246	36.1%	9	10.0%	255	33.0%
Overturn/Rollover	36	5.3%	8	8.9%	44	5.7%
Others	39	5.7%	1	1.1%	40	5.2%
Total	682	100.0%	90	100.0%	772	100.0%
Manner of Collision With Motor Vehicle in-Transport						
Angle	200	55.4%	48	66.7%	248	57.3%
Head-On	96	26.6%	9	12.5%	105	24.2%
Rear-End	46	12.7%	9	12.5%	55	12.7%
Sideswipe	17	4.7%	6	8.3%	23	5.3%
Others/Unknown	2	0.6%	-	-	2	0.5%
Total	361	100.0%	72	100.0%	433	100.0%
Source: FARS, NCSA, 1980-2008						

Figure 10 shows the percentages of the crashes with LEO fatalities in passenger vehicles by the first harmful event for the three time periods. "Collision with motor vehicle in-transport" decreased gradually from 60 percent in the 1980s to 52 percent in the 1990s and to 48 percent in the 2000s. On the contrary, "collision with fixed object" increased from 29 percent to 37 and then to 41 percent, respectively, in these three time periods. "Rollover" remained around 5 percent over the entire period.

For crashes in which the first harmful event is "collision with motor vehicle in-transport," the distribution over the manner of the collision is shown in Table 4. More than half of the passenger vehicle crashes were angle crashes (55%) followed by head-on crashes (27%), rear-end crashes (13%), and sideswipe crashes (5%). On the other hand, motorcycle crashes had mostly angle collisions (67%). Both head-on and rear-end collisions each accounted for 13 percent and sideswipe 8 percent.

Figure 10: Percentage of Passenger Vehicle Crashes With Law Enforcement Officer Fatalities, by First Harmful Event



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 1980-2008

Roadway-Related Characteristics

Table 5 shows the roadway-related characteristics of the crashes with LEO fatalities in passenger vehicles and on motorcycles.

Roadway function class classifies a roadway as rural or urban. During the period from 1980 to 2008, around half (49%) of the motor vehicle crashes with LEO fatalities occurred on roadways in rural areas and the other half (51%) occurred on roadways in urban areas. Of the passenger vehicle crashes, 54 percent occurred on rural areas and 46 percent on urban areas. However, 89 percent of the motorcycle crashes occurred on roadways in urban areas and only 11 percent occurred on roadways in rural areas.

Table 5: Crashes With Law Enforcement Officer Fatalities, By Roadway-Related Characteristics

	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
Roadway Function Class[1]						
Rural	365	53.5%	10	11.1%	375	48.6%
Urban	315	46.2%	80	88.9%	395	51.2%
Unknown	2	0.3%	-		2	0.3%
Total	682	100.0%	90	100.0%	772	100.0%
Roadway Function Class (Road Type)[2]						
Interstate	71	10.8%	9	10.2%	80	10.7%
Arterial	335	51.0%	58	65.9%	393	52.8%
Collector	141	21.5%	4	4.5%	145	19.5%
Local Road	103	15.7%	16	18.2%	119	16.0%
Unknown	7	1.1%	1	1.1%	8	1.1%
Total	657	100.0%	88	100.0%	745	100.0%
Trafficway Flow[3]						
Not Physically Divided (Two-way)	410	64.5%	35	40.7%	445	61.6%
Divided, Median Strip (w/o Traffic Barrier)	150	23.6%	29	33.7%	179	24.8%
Divided, Median Strip (with Traffic Barrier)	53	8.3%	11	12.8%	64	8.9%
Others/Unknown	23	3.6%	11	12.8%	34	4.7%
Total	636	100.0%	86	100.0%	722	100.0%
Roadway Alignment						
Straight	480	70.4%	79	87.8%	559	72.4%
Curve	197	28.9%	10	11.1%	207	26.8%
Unknown	5	0.7%	1	1.1%	6	0.8%
Total	682	100.0%	90	100.0%	772	100.0%
Roadway Profile						
Level	448	65.7%	66	73.3%	514	66.6%
Grade	195	28.6%	22	24.4%	217	28.1%
Others/Unknown	39	5.7%	2	2.2%	41	5.3%
Total	682	100.0%	90	100.0%	772	100.0%
Roadway Surface Condition						
Dry	530	77.7%	86	95.6%	616	79.8%
Wet	118	17.3%	3	3.3%	121	15.7%
Snow/Slush/Ice	24	3.5%	-	-	24	3.1%
Others/Unknown	10	1.5%	1	1.1%	11	1.4%
Total	682	100.0%	90	100.0%	772	100.0%
Weather						
No Adverse Atmospheric Condition	584	85.6%	86	95.6%	670	86.8%
Rain	69	10.1%	2	2.2%	71	9.2%
Snow	10	1.5%	-	-	10	1.3%
Others/Unknown	19	2.8%	2	2.2%	21	2.7%
Total	682	100.0%	90	100.0%	772	100.0%

[1] Rural/Urban definition for the 1980 data was based on Federal Highway Administration and did not necessarily coincide with the U.S Census Bureau's definition.
[2] Roadway function class was classified by road types from 1981.
[3] Trafficway flow data was collected from 1982.
Source: FARS, NCSA, 1980-2008

Roadway function class also classifies a roadway by road types such as arterial, collector, and local road. In this analysis, "principal arterial – interstate" was separated from the other arterials and referred to as "interstate."

"Arterial" road type accounted for the highest level (51%) of the passenger vehicle crashes with LEO fatalities. This is followed by "collector" (22%), "local road" (16%), and "interstate" (11%). In the case of the crashes involving motorcycles, "arterial" road type recorded the highest level (66%) followed by "local road" (18%), "interstate" (10%), and "collector" (5%).

Trafficway flow describes how a roadway is physically divided. A trafficway is not physically divided unless the divider is a median, barrier, or other constructed device. "Median" is defined as the area of a divided trafficway between parallel roads separating the travel lanes in opposite directions. "Traffic barrier" is defined as a physical structure such as a guardrail, a concrete safety barrier, or a rock wall that has the primary function of preventing cross-median travel by deflecting and redirecting vehicles along the roadway. Therefore, trees, curbing, rumble strips, and drain depressions are not barriers.

Of the passenger vehicle crashes with LEO fatalities, 65 percent occurred on "not physically divided (two-way)" trafficways; 24 percent on "divided highway, median strip (without traffic barrier)"; and 8 percent on "divided highway, median strip (with traffic barrier)." On the other hand, 41, 34, and 13 percent of the motorcycle crashes with LEO fatalities, respectively, occurred on the above three types of trafficways.

Roadway alignment data shows that "straight" roads accounted for 70 percent of the passenger vehicle crashes with LEO fatalities and "curve" 29 percent. In contrast, the motorcycle crashes occurred mostly (88%) on "straight" roads and only 11 percent on "curve" roads.

Roadway profile data shows that 66 percent of the passenger vehicle crashes with LEO fatalities had a "level" profile and 29 percent had a "grade" type of roadway profile. For the motorcycle crashes, "level" and "grade" profiles, respectively, accounted for 73 and 24 percent.

The roadway surface condition was identified as "dry" for 78 percent of passenger vehicle crashes with LEO fatalities and as "wet" or "snow/slush/ice" for 21 percent, whereas the road way condition in most motorcycle crashes was identified as "dry" (96%).

For the passenger vehicle crashes with LEO fatalities, 86 percent had no adverse atmospheric condition and 12 percent had rain or snow. In the same way as the roadway surface condition, 96 percent of motorcycle crashes had no adverse atmospheric condition.

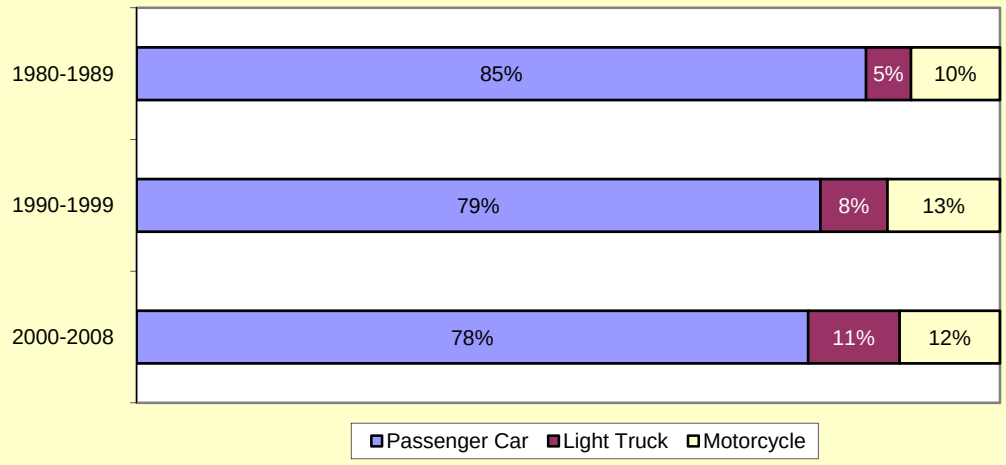
3.2 Characteristics at Vehicle Level

Vehicle Type

During the period from 1980 to 2008, of a total 776 police vehicles that had LEO fatalities, 621 (80%) were passenger cars, 63 (8%) were light trucks, 90 (12%) were motorcycles, and 2 were unknown vehicle type.

Figure 11 shows the proportions of the vehicle types (passenger cars, light trucks, and motorcycles) in the total number of the police vehicles with LEO fatalities for the three time year periods (1980-1989, 1990-1999, and 2000-2008). The proportion of the passenger cars reduced from 85 percent in the 1980s to 79 percent in the 1990s and to 78 percent in the 2000s, while the light trucks gradually increased from 5 percent in the 1980s to 8 percent in the 1990s and then to 11 percent in the 2000s. Motorcycles maintained 10 to 13 percent of the police vehicles with LEO fatalities.

Figure 11: Percentage of Police Vehicles With Law Enforcement Officer Fatalities, by Vehicle Type



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 1980-2008

Emergency Use, Fire Occurrence, and Rollover

Table 6 shows emergency use, fire occurrence, and rollover of the police vehicles with LEO fatalities at the time of the crashes.

Emergency use refers to a vehicle that is traveling with physical emergency signals in use such as red light blinking and siren sounding, etc. Forty-two percent of the police passenger vehicles and 37 percent of police motorcycles with LEO fatalities were emergency use vehicles in the FARS data.

Fire occurred in 10 percent of the police passenger vehicles and 4 percent of the police motorcycles with LEO fatalities.

Rollover data shows that 27 percent of the police passenger vehicles with LEO fatalities rolled over with rollover as a first event for 5 percent and as a subsequent event for 21 percent.

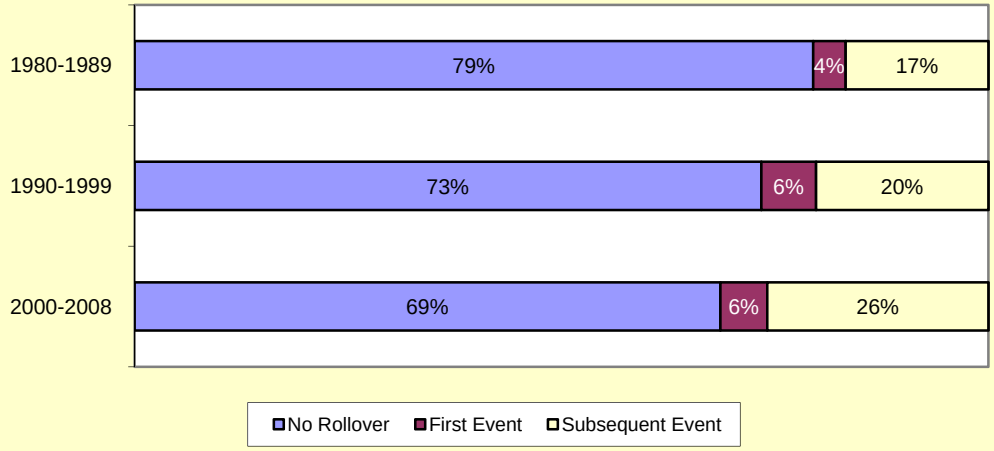
As shown in Figure 12, rollover as a subsequent event was 17 percent in the 1980s. It increased to 20 percent in the 1990s and to 26 percent in the 2000s. As a result, rollover in total increased from 21 percent in the 1980s to 27 percent in the 1990s and then to 31 percent in the 2000s.

Table 6: Police Vehicles With Law Enforcement Officer Fatalities, By Emergency Use, Fire Occurrence, and Rollover

	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
Emergency Use						
No	400	58.3%	57	63.3%	457	58.9%
Yes	286	41.7%	33	36.7%	319	41.1%
Total	686	100.0%	90	100.0%	776	100.0%
Fire Occurrence						
No	615	89.7%	86	95.6%	701	90.3%
Yes	71	10.3%	4	4.4%	75	9.7%
Total	686	100.0%	90	100.0%	776	100.0%
Rollover						
No Rollover	503	73.3%	90	100%	593	76.4%
First Event	36	5.2%	-	-	36	4.6%
Subsequent Event	147	21.4%	-	-	147	18.9%
Total	686	100.0%	90	100.0%	776	100.0%

Source: FARS, NCSA, 1980-2008

Figure 12: Percentage of Police Passenger Vehicles With Law Enforcement Officer Fatalities, by Rollover



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 1980-2008

Most Harmful Event

As shown in Table 7, the most harmful event of the police passenger vehicles with LEO fatalities consisted of 47 percent that had "collision[s] with motor vehicle in-transport," 29-percent "collision[s] with fixed object," and 14 percent "rollover[s]." For the motorcycles, "collision[s] with motor vehicle[s] in-transport" was 76 percent followed by "collision[s] with fixed object" (13%) and "rollover[s]" (9%).

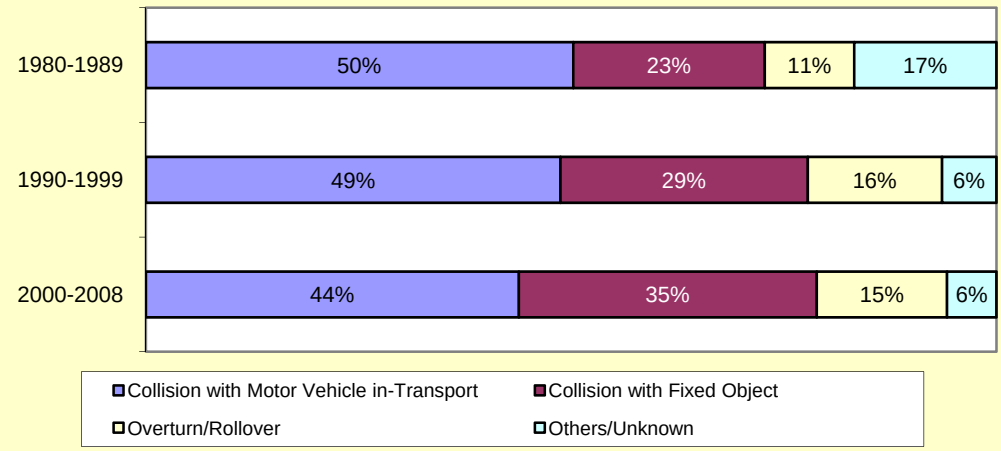
The percent of the police passenger vehicles with LEO fatalities that collided with fixed objects steadily increased from 23 percent in the 1980s to 35 percent in the 2000s as shown in Figure 13. On the contrary, the police passenger vehicles with LEO fatalities that collided with motor vehicles in-transport gradually decreased from 50 percent to 44 percent over the three time periods.

Table 7: Police Vehicles With Law Enforcement Officer Fatalities, By Most Harmful Event

	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
Most Harmful Event						
Collision With Motor Vehicle in Transport	324	47.2%	68	75.6%	392	50.5%
Collision With Fixed Object	202	29.4%	12	13.3%	214	27.6%
Overturn/Rollover	96	14.0%	8	8.9%	104	13.4%
Others	64	9.3%	2	2.2%	66	8.5%
Total	686	100.0%	90	100.0%	776	100.0%

Source: FARS, NCSA, 1980-2008

Figure 13: Percentage of Police Passenger Vehicles With Law Enforcement Officer Fatalities, by Most Harmful Event



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 1980-2008

Impact Point, Vehicle Maneuver, and Crash Avoidance Maneuver

Initial (or principal) impact point identifies the area on the vehicle that produces the first (or the most severe) instance of injury or property damage involving the vehicle. The FARS codes the impact point as a clock point on the vehicle. In this study, the clock points were categorized into front, left side, right side, and rear. The 11, 12, and 1 o'clock points represent the front; the 2, 3, and 4 o'clock points represent the right side; the 5, 6, and 7 o'clock points represent the rear; and the 8, 9, and 10 o'clock points represent the left side.

The frequency distribution of the initial impact points of police vehicles with LEO fatalities is presented in Table 8. Forty-seven percent of the police passenger vehicles had "front" as the initial impact point, 24 percent "left side", 13 percent "right side", and 7-percent "rear". On the other hand, almost three-fourth (73%) of the initial impact points of the police motorcycles were recorded as "front". The principal impact point shows a pattern that is similar to the pattern shown by the initial impact point.

Vehicle maneuver captures a driver's action or intended action prior to entering a crash situation. As seen in Table 8, "going straight" (61%) was the major vehicle maneuver type for police passenger vehicles with LEO fatalities. This is followed by "negotiating curve" (19%) and "maneuvering to avoid animal/pedestrian/object" (6%). In the case of motorcycles, "going straight" (71%) is followed by "passing/overtaking another vehicle" (11%) and "negotiating curve" (8%).

Table 8 also shows a driver's crash avoidance maneuver for the police passenger vehicles and motorcycles with LEO fatalities. Drivers of 37 percent of the police passenger vehicles and 29 percent of the police motorcycles did not attempt to avoid the crashes. In attempting to avoid crashes, 13 percent of the police passenger vehicle drivers used steering as a maneuver; 6 percent used braking; and 10 percent used steering as well as braking. On the other hand, 19 percent of the police motorcycle drivers used braking; 9 percent used steering; and 14 percent used both steering and braking.

Table 8: Characteristics Related to Police Vehicles With Law Enforcement Officer Fatalities

	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
Initial Impact Point						
Front	323	47.1%	66	73.3%	389	50.1%
Left Side	163	23.8%	7	7.8%	170	21.9%
Right Side	92	13.4%	4	4.4%	96	12.4%
Rear	48	7.0%	3	3.3%	51	6.6%
Non-Collision	28	4.1%	3	3.3%	31	4.0%
Others/Unknown	32	4.7%	7	7.8%	39	5.0%
Total	686	100.0%	90	100.0%	776	100.0%
Principal Impact Point						
Front	288	42.0%	62	68.9%	350	45.1%
Left Side	166	24.2%	7	7.8%	173	22.3%
Right Side	96	14.0%	5	5.6%	101	13.0%
Rear	47	6.9%	4	4.4%	51	6.6%
Non-Collision	28	4.1%	3	3.3%	31	4.0%
Others/Unknown	61	8.9%	9	10.0%	70	9.0%
Total	686	100.0%	90	100.0%	776	100.0%
Vehicle Maneuver[1]						
Going Straight	389	60.8%	61	70.9%	450	62.0%
Negotiating Curve	119	18.6%	7	8.1%	126	17.4%
Maneuvering to Avoid Animal/Ped/Obj	38	5.9%	3	3.5%	41	5.6%
Passing/Overtaking Another Vehicle	23	3.6%	9	10.5%	32	4.4%
Stopped in Traffic Lane	15	2.3%	1	1.2%	16	2.2%
Others	56	8.8%	5	5.8%	61	8.4%
Total	640	100.0%	86	100.0%	726	100.0%
Crash Avoidance Maneuver[2]						
No Maneuver	173	37.3%	17	28.8%	190	36.3%
Braking	29	6.3%	11	18.6%	40	7.6%
Steering	61	13.1%	5	8.5%	66	12.6%
Steering and Braking	44	9.5%	8	13.6%	52	9.9%
Not Reported	157	33.8%	18	30.5%	175	33.5%
Total	464	100.0	59	100.0%	523	100.0%

[1] Vehicle maneuver was collected from 1982.

[2] Crash avoidance maneuver was collected from 1991.

Source: FARS, NCSA, 1980-2008

Driver-Related Factors

During the period from 1982 to 2008, of 726 police vehicles with LEO fatalities, 528 vehicles had at least one driver-related factor.[2] A total of 931 driver-related factors were coded for 476 police passenger vehicles and 83 driver-related factors for 52 police motorcycles. Table 9 shows the list of only those driver-related factors that were coded for more than 20 police vehicles.

"Failure to keep in proper lane or running off road" and "driving too fast for conditions or in excess of posted speed limit" were the most occurring driver-related factors accounting for 225 and 220 police vehicles with LEO fatalities, respectively. "High speed chase with police in pursuit" was coded for 69 police vehicles. "Police or law enforcement officer," which was coded for 113 police vehicles since 2002, is an obvious driver-related factor for the police vehicles with LEO fatalities.

Table 9: Driver-Related Factors in Police Vehicles With Law Enforcement Officer Fatalities

	Passenger Vehicle	Motorcycle	Total
Driver-Related Factors[1]			
Failure to keep in proper lane or running off road	218	7	225
Driving too fast for conditions or in excess of posted speed limit	203	17	220
Police or law enforcement officer (since 2002)	95	18	113
High-speed chase with police in pursuit	64	5	69
Inattentive/careless (talking, eating, car phone, etc.)	26	3	29
Operating the vehicle in an erratic, reckless, careless, or negligent manner or operating at erratic or suddenly changing speed	25	3	28
Ice, water, snow, slush, sand, dirt, oil, wet leaves on road	27	-	27
Failure to obey traffic actual signs, traffic control devices, or traffic officers, failure to observe safety zone traffic laws	25	1	26
Over-correcting	23	-	23
Failure to yield right-of-way	20	1	21
⋮	⋮	⋮	⋮
Total	931	83	1014
Number of Police Vehicles With Driver-Related Factors	476	52	528
Number of Police Vehicles	640	86	726

[1] Driver-related factors were collected from 1982.
Source: FARS, NCSA, 1982-2008

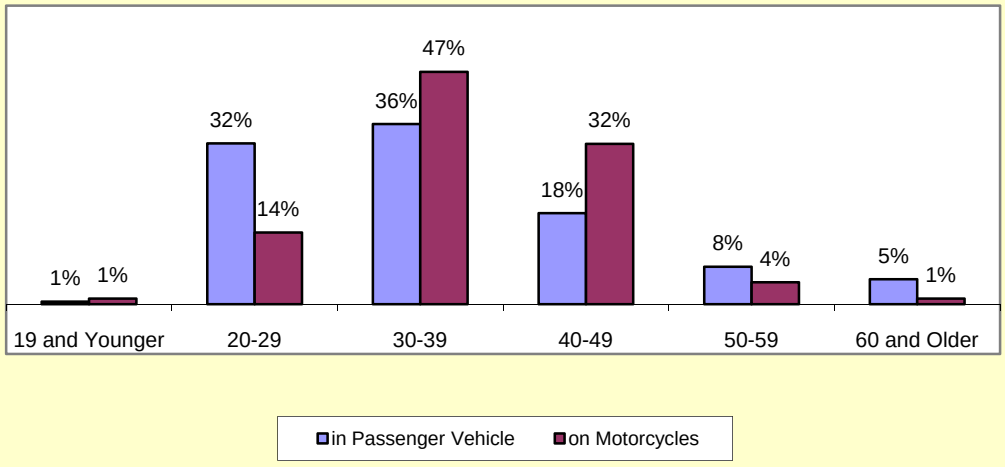
[2] For each driver, driver-related factors were coded up to three factors from 1982 to 1996 and four factors since 1997.

3.3 Characteristics at Person Level

Age

Figure 14 shows the distribution of LEO fatalities in passenger vehicles over six age groups: 19 and younger, 20 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 and older. The highest percentage (36%) belongs to the age group 30 to 39 followed by 32 percent for 20 to 29, 18 percent for 40 to 49, and 8 percent for 50 to 59. The law enforcement officers killed in motorcycle crashes were generally older as compared to those killed in passenger vehicle crashes. In the case of the LEO fatalities on motorcycles, age group 30 to 39 accounted for 47 percent, 40 to 49 32 percent, and 20 to 29 only 14 percent. Note that the number of LEO fatalities for the age group 19 and younger should be zero, since the minimum age of a law enforcement officer is 21. Five fatalities in the 19-and-younger cohort who might not be law enforcement officers were included because all occupants in the police vehicles were assumed as law enforcement officers in this analysis.

Figure 14: Percentage of Law Enforcement Officer Fatalities, by Age



Source: FARS, NCSA, 1980-2008

Sex, Person Type, and Seating Position

Ninety-three percent of LEO fatalities in motor vehicle crashes (92% in the passenger vehicle crashes and 99% in the motorcycle crashes) were males as shown in Table 10. This is a reflection of the fact that the majority of the police officers are male.

Table 10 shows that 84 percent of LEO fatalities in the passenger vehicles were drivers and 16 percent were passengers. At the time of the crashes, 84 percent were in the driver-side front seat, 12 percent were in the passenger-side front seat, and 2 percent were in the back seat.

Table 10: Law Enforcement Officer Fatalities, by Sex, Person Type, and Seating Position

	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
Sex						
Male	676	92.2%	89	98.9%	765	93.0%
Female	57	7.8%	1	1.1%	58	7.0%
Total	733	100.0%	90	100.0%	823	100.0%
Person Type						
Driver	614	83.8%	90	100.0%	704	85.5%
Passenger	116	15.8%	-	-	116	14.1%
Others[1]	3	0.4%	-	-	3	0.4%
Total	733	100.0%	90	100.0%	823	100.0%
Seating Position						
Front Seat –Driver's Side	616	84%	90	100.0%	706	85.8%
Front Seat–Passenger's Side	91	12.4%	-	-	91	11.1%
Back Seat	16	2.2%	-	-	16	1.9%
Others/Unknown	10	1.4%	-	-	10	1.2%
Total	733	100.0%	90	100.0%	823	100.0%

[1] Occupant of motor vehicle not in-transport
Source: FARS, NCSA, 1980-2008

Restraint Use, Air Bag Availability and Deployment, and Ejection

Table 11 shows the frequency distribution of restraint use, air bag availability and deployment, and ejection from the vehicle of LEO fatalities during the period from 1980 to 2008.

Restraint use data shows that 45 percent of the law enforcement officers killed in passenger vehicle crashes used restraints such as shoulder belts, lap belts, lap-and-shoulder belts, or other types, while 42 percent did not use any restraint system. Of the law enforcement officers killed in motorcycle crashes, 91 percent were wearing helmets at the time of the crashes.

During the period from 1990 to 2008 when air bag data was collected, the air bags were deployed in 43 percent of LEO fatalities in passenger vehicles and were not deployed in 22 percent. (The remaining 35% were "Not Applicable/Unknown.")

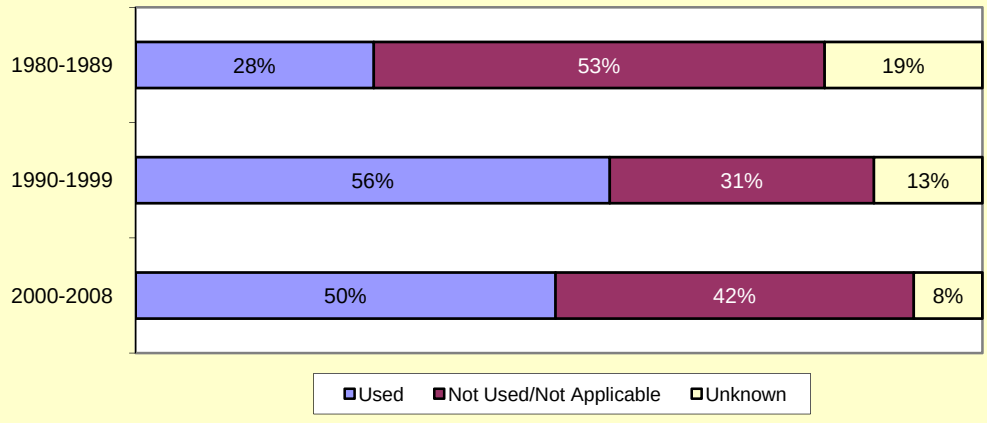
Ejection refers to a person being thrown from a compartment of a motor vehicle during the course of the crash. Of the 733 law enforcement officers killed in passenger vehicle crashes, 19 percent were ejected. When reviewed by ejection types, 15 percent were totally ejected and 4 percent were partially ejected.

Table 11: Law Enforcement Officer Fatalities, by Restraint System Use, Air Bag Availability/Deployment, and Ejection						
	Passenger Vehicle		Motorcycle		Total	
	Number	Percent	Number	Percent	Number	Percent
Restraint System Use						
Used	328	44.7%	82	91.1%	410	49.8%
Not Used/Not Applicable	311	42.4%	4	4.4%	315	38.3%
Unknown	94	12.8%	4	4.4%	98	11.9%
Total	733	100.0%	90	100.0%	823	100.0%
Air Bag Availability and Deployment[1]						
Deployed	218	43.4%	-	-	218	38.4%
Non-Deployed	109	21.7%	-	-	109	19.2%
Not Applicable/Unknown	175	34.9%	66	100.0%	241	42.4%
Total	502	100.0%	66	100.0%	568	100.0%
Ejection						
Not Ejected	591	80.6%	85	94.4%	676	82.1%
Totally Ejected	111	15.1%	-	-	111	13.5%
Partially Ejected	28	3.8%			28	3.4%
Not Applicable/Unknown	3	0.4%	5	5.6%	8	1.0%
Total	733	100.0%	90	100.0%	823	100.0%

[1] Air bag availability and deployment data was counted from 1990.
Source: FARS, NCSA, 1980-2008

The FARS data shows that the restraint use and air bag availability and deployment of the law enforcement officers killed in the passenger vehicle crashes changed over the three time periods.

Figure 15: Percentage of Law Enforcement Officer Fatalities In Passenger Vehicles, by Restraint System Use

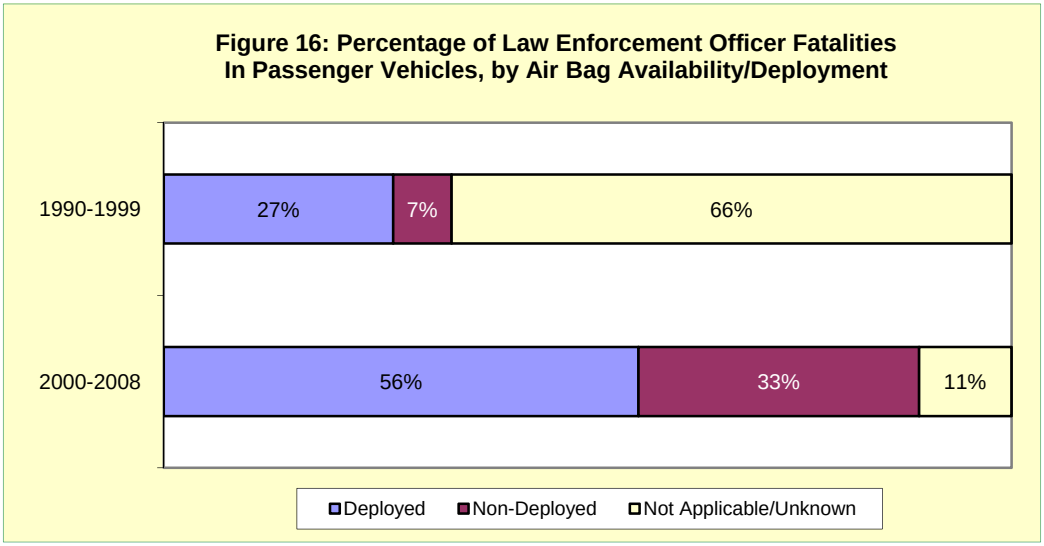


Source: FARS, NCSA, 1980-2008

As shown in Figure 15, of law enforcement officers killed in passenger vehicle crashes, 28 percent used restraints and 53 percent did not use restraints in the 1980s. However, in the 1990s, the restraint system use increased by 28 percentage points resulting in 56 percent of "used" and 31 percent of "not used." Recent LEO fatality data showed that law enforcement officers who used restraints decreased to 50 percent while those who did not use restraints increased to 42 percent in the 2000s.

Figure 16 shows that air bags were deployed in 56 percent of LEO fatalities in passenger vehicles in the 2000s, which is a 29-percentage-point increase from the 27 percent in the 1990s. The percentage of LEO fatalities in which air bags were available but not deployed also increased from 7 percent in the 1990s to 33 percent in the 2000s.

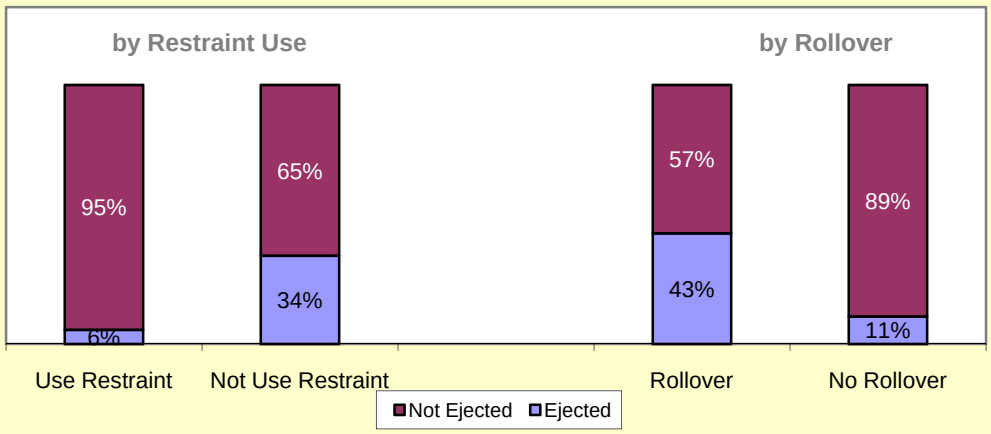
Figure 16: Percentage of Law Enforcement Officer Fatalities In Passenger Vehicles, by Air Bag Availability/Deployment



Source: FARS, NCSA, 1990-2008

Ejection data of LEO fatalities in passenger vehicles was analyzed along with restraint system use and rollover that are considered to be associated with ejection. Figure 17 shows that 6 percent of the LEO fatalities who used restraint systems in passenger vehicles were ejected. However, 34 percent of those who did not use restraints were ejected. Forty-three percent of the LEO fatalities in the passenger vehicles that rolled over were ejected, while 11 percent of those in the passenger vehicles that did not roll over were ejected.

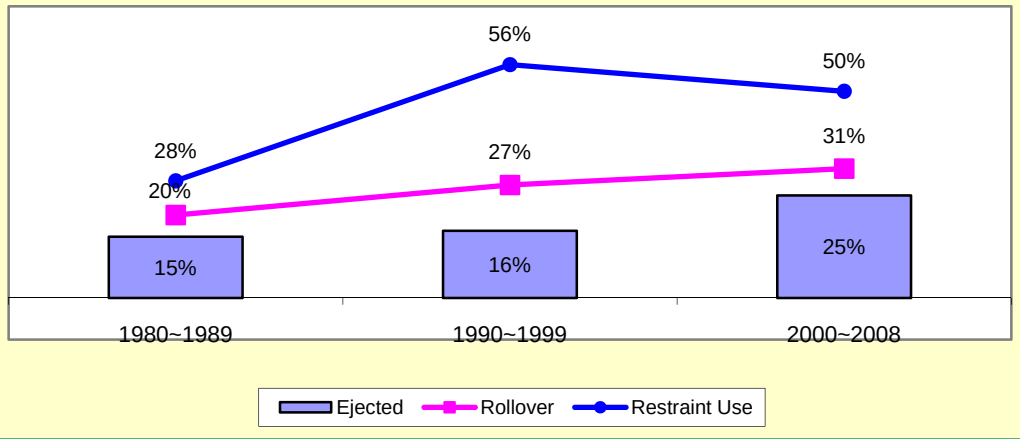
Figure 17: Percentage of Ejected/NotEjected Law Enforcement Officer Fatalities in Passenger Vehicles, by Restraint System Use/Rollover[1]



The percentages may not add to 100 because of rounding.
[1] Rollovers were counted in the person level file.
Source: FARS, NCSA, 1980-2008

Figure 18 shows the percentage frequencies of the ejected, rolled over, and restrained LEO fatalities in passenger vehicles for the three time periods. The ejected LEO fatalities increased only 1 percentage point from 15 percent in the 1980s to 16 percent in the 1990s due to a large increase in restraint use (from 28% in the 1980s to 56% in the 1990s), while rollover increased 7 percentage points (from 20% in the 1980s to 27 % in the 1990s). On the other hand, the ejected LEO fatalities increased 9 percentage points from 16 percent in the 1990s to 25 percent in the 2000s because rollovers increased 4 percentage points (from 27% in the 1990s to 31% in the 2000s) and restraint use decreased 6 percentage points (from 56% in the 1990s to 50% in the 2000s).

Figure 18: Percentage of Law Enforcement Officer Fatalities In Passenger Vehicles by Rollover,[1] Restraint System Use, and Ejection



[1] Rollovers were counted in the person level file.
Source: FARS, NCSA, 1980-2008

4. Comparison of the Characteristics of LEO and Non-LEO Fatalities

The characteristics of fatalities in passenger vehicle crashes were compared between the LEO and non-LEO groups using the FARS data from 2000 to 2008. The focus of this comparison was on the recent 9 years because some characteristics of law enforcement officers' fatalities have changed over time as shown by the analysis results in the previous sections. The characteristics of fatalities on motorcycles were not compared between the LEO and non-LEO groups because the number of cases in the LEO group is too small to justify the comparison.

The LEO and non-LEO groups were formed at crash, vehicle, and person levels as shown in Table 12. The names and definitions of the LEO and non-LEO groups as presented in Table 12 at each level are used throughout this section.

Table 12: Definition and Frequencies of LEO and Non-LEO Groups At Crash, Vehicle, and Person Levels

LEO/Non-LEO Group	Definition	Number of Cases
LEO fatality crash	Crash that had at least one occupant fatality in the police passenger vehicle	272
Non-LEO fatality crash	Crash that is not LEO fatality crash and had at least one fatality in the passenger vehicle	243,817
LEO fatality vehicle	Police passenger vehicle with occupant fatality in the LEO fatality crash	274
Non-LEO fatality vehicle	Passenger vehicle with occupant fatality in the non-LEO fatality crash	249,531
LEO fatalities	Occupant fatalities in the police passenger vehicle at the LEO fatality crash	284
Non-LEO fatalities	Occupant fatalities in the passenger vehicle at the non-LEO fatality crash	277,774

Source: FARS, NCSA, 2000-2008

To find the characteristics that are significantly different for the LEO and non-LEO groups, a chi-square test was conducted for the variables that have been discussed in the previous sections.

In general, chi-square test is used to determine whether there is a significant association between two categorical variables. In the current application, one categorical variable is a variable to be analyzed (for example, rollover, age, etc.) and the other categorical variable is a fatality group, LEO or non-LEO. A small p-value (smaller than a chosen significance level, e.g. 0.1, 0.05, or 0.001) shows that there is a sufficient statistical evidence to conclude that the two variables are associated with each other. In other words, the variable to be analyzed has significantly different characteristic for the LEO and non-LEO groups.

Table 13 shows variables of interest at crash, vehicle, and person level with the corresponding p-values. In the following section, the characteristics of fatalities are analyzed for the variables whose p-values are less than 0.01 by comparing the LEO and non-LEO groups.

Table 13: Summary of the Chi-Square Test

Variable	P-value	P-value <0.01
Crash Level		
Crash Month[1]	0.025	
Crash Time[2]	<0.0001	√
First Harmful Event	0.006	√
Manner of Collision	0.5370	
Roadway Function Class (Rural/Urban)	0.0008	√
Roadway Function Class (Road Type)	0.0282	
Trafficway Flow	0.5464	
Roadway Alignment	0.0215	
Roadway Profile	0.1697	
Roadway Surface Condition	0.0041	√
Weather	0.4076	
Vehicle Level		
Emergency Use	<0.0001	√
Fire Occurrence	<0.0001	√
Rollover	0.0014	√
Most Harmful Event	0.0002	√
Initial Impact Point	0.0001	√
Principal Impact Point	<0.0001	√
Vehicle Maneuver	<0.0001	√
Crash Avoidance Maneuver	<0.0001	√
Person Level		
Age	<0.0001	√
Sex	<0.0001	√
Person Type	<0.0001	√
Seating Position	<0.0001	√
Restraint Use	0.0022	√
Air Bag	<0.0001	√
Ejection	0.4684	

[1] Crash month was categorized by two groups (May - October and November - April) based on the distribution of the LEO fatality crash during 2000~2008.
[2] Crash time was categorized by three work shift (8 a.m.-3:59 p.m., 4 p.m.-11:59 p.m., and midnight-7:59 a.m.).
√ Significant at 0.01 level.
Source: FARS, NCSA, 2000-2008

4.1 Comparison at Crash Level

Crash Time

A chi-square test indicates that the crash time is significantly different between the LEO fatality crashes and non-LEO fatality crashes when the crash time was categorized by three work shifts: 8 a.m.-3:59 p.m., 4 p.m.-11:59 p.m., and midnight-7:59 a.m.. As shown in Table 14, the LEO fatality crashes occurred most frequently (44%) during the midnight-7:59 a.m. shift, while the non-LEO fatality crashes occurred least frequently (30%) during that shift. For the 8 a.m.-3:59 p.m. shift, the LEO fatality crashes occurred least frequently (21%) while the non-LEO fatality crashes occurred at the average level (33%).

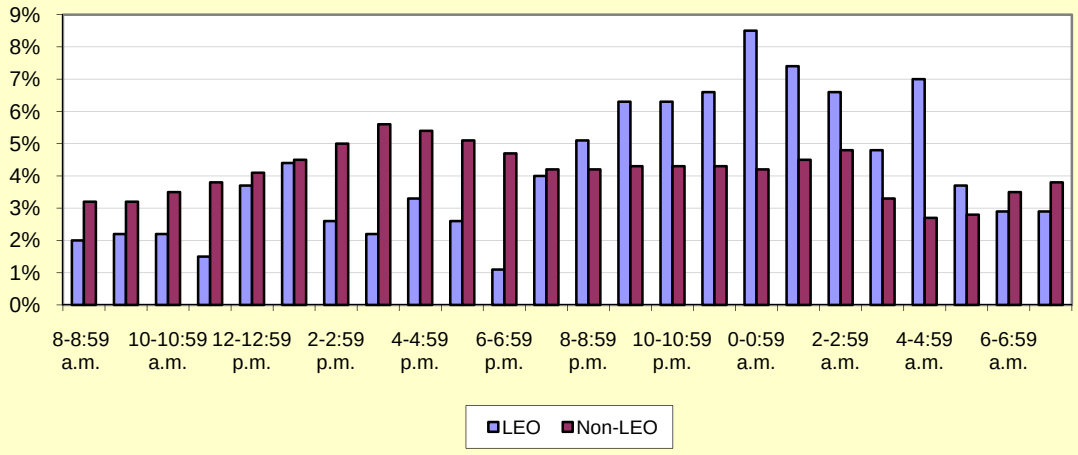
Figure 19 shows that the hourly percentage of the LEO fatality crashes had a wide range from 1.1 to 8.5 percent. The LEO fatality crashes occurred frequently during the dark hours (8 p.m.-4:59 a.m.) with an average of 6.5 percent. On the other hand, the hourly percentage of the non-LEO fatality crashes was stable ranging from 2.7 to 5.6 percent. The non-LEO fatality crashes occurred in the afternoon hours (1 p.m.-6:59 p.m.) with a relatively higher percentage (average 5.1%).

Table 14: Percentage of LEO/Non-LEO Fatality Crashes, by Crash Time (Work Shift)

	LEO Fatality Crashes	Non-LEO Fatality Crashes
Crash Time (Work Shift)		
8 a.m.-3:59 p.m.	21.0%	32.9%
4 p.m.-11:59 p.m.	35.3%	36.5%
midnight-7:59 a.m.	43.8%	29.8%
Unknown	0.0%	0.9%

Source: FARS, NCSA, 2000-2008

Figure 19: Percentage of LEO/Non-LEO Fatality Crashes, by Crash Time



Source: FARS, NCSA, 2000-2008

First Harmful Event, Roadway Function Class, and Roadway Surface Condition

Table 15 shows percent frequencies of the LEO and non-LEO fatality crashes by the first harmful event, roadway function class, and roadway surface condition that have significant differences between the two groups.

The LEO and non-LEO fatality crashes had the same descending order of frequencies with respect to the first harmful events: "collision with motor vehicle in-transport," "collision with fixed object," and "rollover." However, the percentage of LEO fatality crashes is considerably lower for "rollover" as compared to the non-LEO fatality crashes - the frequency of "rollover" accounted for 6 percent of the LEO fatality crashes and 12 percent of the non-LEO fatality crashes.

The LEO fatality crashes occurred on roadways in urban areas more frequently as compared to the non-LEO fatality crashes. Forty-seven percent of the LEO fatality crashes occurred in urban areas and 52 percent in rural areas. On the other hand, 37 percent of the non-LEO fatality crashes occurred in urban areas and 63 percent in rural areas.

The LEO fatality crashes occurred under more adverse roadway surface conditions such as wet, snow, slush, or ice than the non-LEO fatality crashes. Roadway surface conditions such as wet, snow, slush, or ice were recorded for 26 percent of the LEO fatality crashes and 18 percent for the non-LEO fatality crashes.

Table 15: Percentage of LEO/Non-LEO Fatality Crashes, By First Harmful Event, Roadway Function Class, and Roadway Surface Condition

	LEO Fatality Crashes	Non-LEO Fatality Crashes
First Harmful Event		
Collision With Motor Vehicle in-Transport	47.8%	45.8%
Collision With Fixed Object	41.2%	38.2%
Overturn/Rollover	5.5%	12.1%
Unknown	5.5%	3.9%
Roadway Function Class		
Rural	52.2%	62.9%
Urban	47.4%	36.5%
Unknown	0.4%	0.6%
Roadway Surface Condition		
Dry	72.8%	81.4%
Wet	21.0%	14.1%
Snow/Slush/Ice	5.1%	3.7%
Others/Unknown	1.1%	0.8%

Source: FARS, NCSA, 2000-2008

4.2 Comparison at Vehicle Level

Emergency Use and Fire Occurrence

Emergency use data shows apparent difference between the LEO fatality vehicles and non-LEO fatality vehicles. As shown in Table 16, 39 percent of the LEO fatality vehicles used physical emergency signals while none of the non-LEO fatality vehicles used emergency signals.

Also, the FARS data shows that the incidence of fire at the time of the crash was more frequent on the LEO fatality vehicles (11%) than non-LEO fatality vehicles (4%).

Table 16: Percentage of LEO/Non-LEO Fatality Vehicles, By Emergency Use and Fire Occurrence

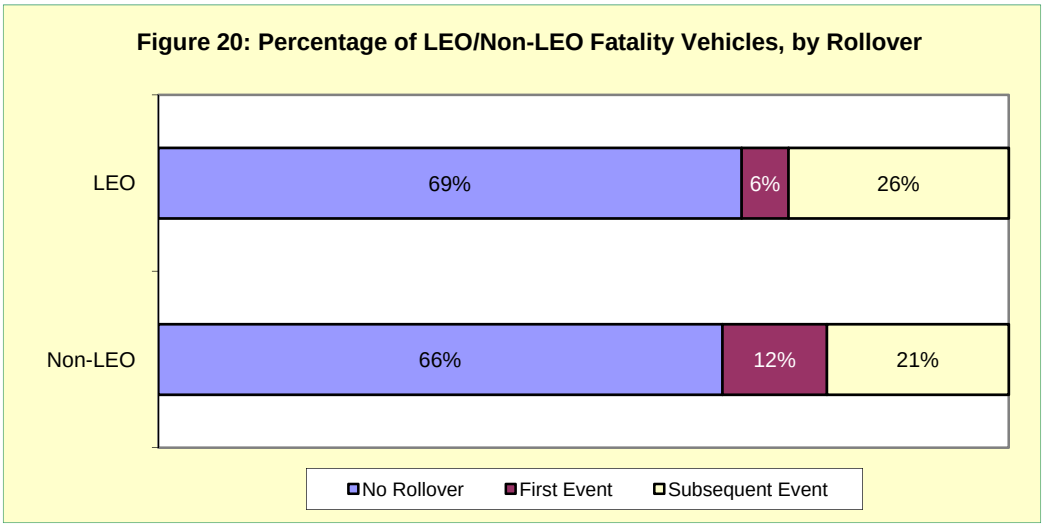
	LEO Fatality Vehicles	Non-LEO Fatality Vehicles
Emergency Use		
No	60.6%	100.0 %
Yes	39.4%	0.0%
Fire Occurrence		
No	89.1%	95.9%
Yes	10.9%	4.1%

Source: FARS, NCSA, 2000-2008

Rollover

As shown in Figure 20, rollover status did not show any significant[3] difference between the LEO fatality vehicles (rollover: 69%, no rollover: 31%) and non-LEO fatality vehicles (rollover: 66%, no rollover: 34%). However, chi-square test showed that rollovers had a significant difference between the LEO fatality vehicles and non-LEO fatality vehicles when vehicles were categorized as "no rollover," "first event," and "subsequent event." For the LEO fatality vehicles, 6 percent had rollover as a first event and 26 percent as a subsequent event, whereas for the non-LEO fatality vehicles, rollover was recorded as a first event in 12 percent of the cases and as a subsequent event in 21 percent of the cases.

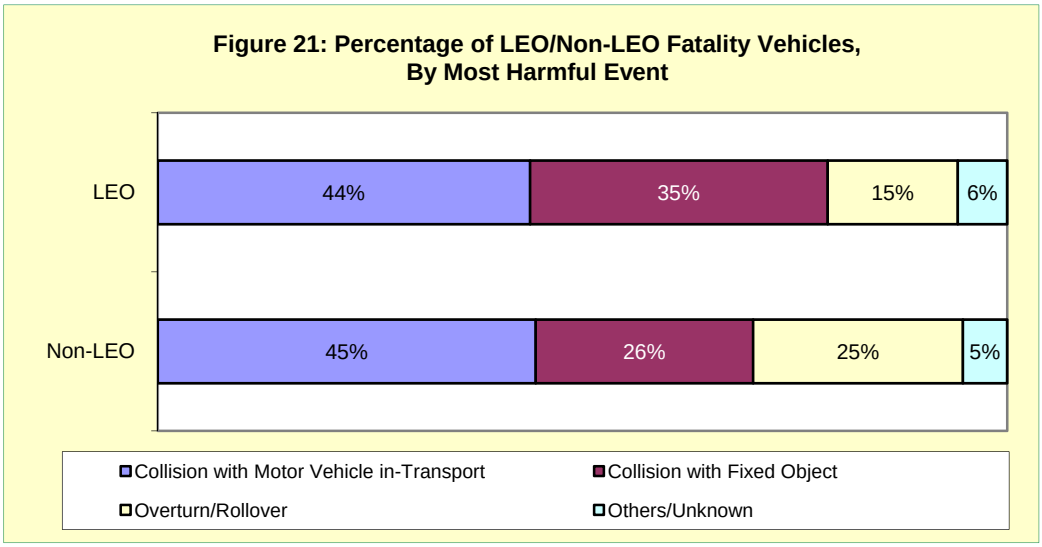
[3] If the rollover was categorized only by "rollover" and "no rollover," the p-value of the chi-square test was 0.43.



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 2000-2008

Most Harmful Event

As shown in Figure 21, "collision with motor vehicle in-transport" was the most frequent occurring most harmful event for both the LEO fatality vehicles (44%) and non-LEO fatality vehicles (45%). However, "collision with fixed object" was 35 percent for LEO fatality vehicles which was 9 percentage points higher than 26 percent for non-LEO fatality vehicles. On the contrary, "rollover" was 15 percent for LEO fatality vehicles which was 10 percentage points lower than 25 percent for non-LEO fatality vehicles.



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 2000-2008

Impact Point, Vehicle Maneuver, and Crash Avoidance Maneuver

Table 17 provides a list of the other vehicle-related characteristics that show significant differences between the LEO fatality vehicles and non-LEO fatality vehicles as concluded from the chi-square test.

The data on initial impact point shows that the LEO fatality vehicles had 5 percentage points less incidents of "front" impact (48%), but 7 percentage points more "left side" impact (22%) and 3 percentage points more "rear" impact (8%) as compared to the non-LEO fatality vehicles. Vehicles with no initial impact point due to "non-collision" were 4 percent for the LEO fatality vehicles while they were 9 percent for the non-LEO fatality vehicles. Principal impact point shows a similar pattern as initial impact point.

Table 17: Percentage of LEO/Non-LEO Fatality Vehicles, By Impact Point, Vehicle Maneuver, and Crash Avoidance Maneuver

	LEO Fatality Vehicles	Non-LEO Fatality Vehicles
Initial Impact Point		
Front	47.8%	53.1%
Left Side	22.3%	14.8%
Right Side	13.5%	12.9%
Rear	7.7%	5.0%
Non-Collision	3.6%	9.4%
Others/Unknown	5.1%	4.7%
Principal Impact Point		
Front		50.3%
Left Side	23.0%	15.6%
Right Side		13.4%
Rear		4.5%
Non-Collision	3.6%	9.4%
Others/Unknown	6.9%	6.8%
Vehicle Maneuver		
Going Straight		65.8%
Negotiating Curve		17.5%
Maneuvering to Avoid Animal/Ped/Obj		1.0%
Making a U-Turn		0.5%
Stopped in Traffic Lane		1.2%
Passing/Overtaking Another Vehicle		2.5%
Changing Lane or Merging		2.1%
Turning Left		5.9%
Others		3.5%
Crash Avoidance Maneuver		
No Maneuver	38.7%	41.5%
Braking	4.4%	4.6%
Steering	15.0%	12.0%
Steering and Braking	9.1%	3.9%
Others/Not Reported	32.8%	38.0%

Source: FARS, NCSA, 2000-2008

Vehicle maneuver shows substantial differences between the LEO fatality vehicles and non-LEO fatality vehicles at "going straight" (61%: LEO fatality vehicles, 66%: non-LEO fatality vehicles); "maneuvering to avoid animal/pedestrian/object" (7%: LEO fatality vehicles, 1%: non-LEO fatality vehicles); and "turning left" (2%: LEO fatality vehicles, 6%: non-LEO fatality vehicles).

In an attempt to avoid crashes, drivers of the LEO fatality vehicles used 3 percentage points more "steering" (15%) and 5 percentage points more "steering and braking" (9%) as compared to the drivers of non-LEO fatality vehicles. However "braking" alone did not show any substantial difference. On the other hand, 39 percent of the drivers of LEO fatality vehicles did "no maneuver" to avoid a crash while 42 percent of the drivers of non-LEO fatality vehicles did "no maneuver."

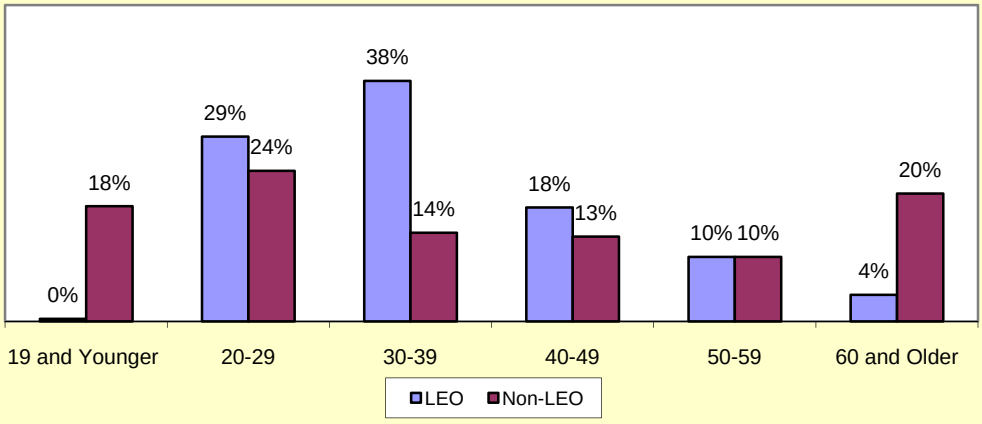
4.3 Comparison at Person Level

It is apparent that the LEO fatalities have significantly different personal characteristics from those of the non-LEO fatalities. The reason for this difference lies in the fact that the LEO fatalities are a restricted group of occupant fatalities who were in police passenger vehicles, whereas the non-LEO fatalities are a general group of occupant fatalities in passenger vehicles.

Age

As shown in Figure 22, 30- to 39-year-old LEOs had the highest percentage (38%) of fatalities. The age groups 20 to 29, 40 to 49, and 50 to 59, respectively, accounted for 29, 18, and 10 percent of the fatalities. The LEO fatalities who were in the age groups of 19 and younger or 60 and older were rare (4%). For the non-LEO fatalities, however, 60 and older (20%) and 19 and younger 19 (18%) just followed the highest age group, 20 to 29 (24%).

Figure 22: Percentage of LEO/Non-LEO Fatalities, by Age



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 2000-2008

Sex, Person Type, Seating Position

Most of the LEO fatalities were males (91%), whereas 65 percent of the non-LEO fatalities were males and 35 percent were females, as shown in Table 18.

Table 18 shows 87 percent of the LEO fatalities were drivers and 12 percent were passengers, while 69 percent of non-LEO fatalities were drivers and 30 percent were passengers. This shows that the higher percentage of the LEO fatalities were drivers as compared to the non-LEO fatalities.

Similarly, 88 percent of the LEO fatalities were seated in the driver-side front seat, 10 percent in the passenger-side front seat, and 2 percent in the back seat. For the non-LEO fatalities, 69 percent were in the driver seat, 20 percent in the passenger-side front seat, and 9 percent in the back seat.

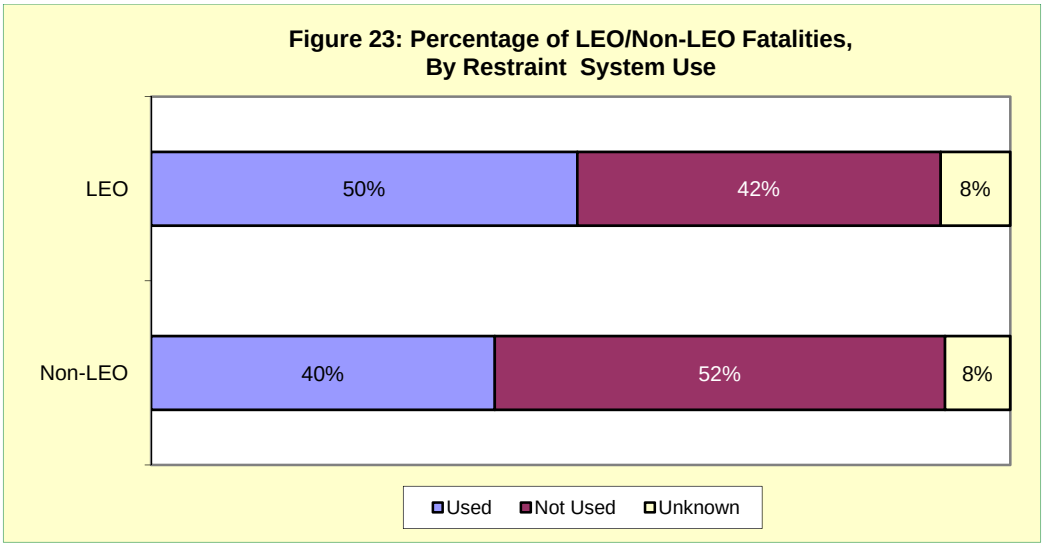
Table 18: Percentage of LEO/Non-LEO Fatalities, By Age, Sex, Person Type, and Seating Position

	LEO fatalities	Non-LEO fatalities
Sex		
Male	90.8%	65.2%
Female	9.2%	34.8%
Person Type		
Driver	87.0%	69.4%
Passenger	12.0%	30.3%
Others	1.1%	0.3%
Seating Position		
Front Seat –Driver's Side	87.7%	69.4%
Front Seat – Passenger's Side	9.9%	19.5%
Back Seat	2.1%	8.6%
Others/Unknown	0.4%	2.4%

Source: FARS, NCSA, 2000-2008

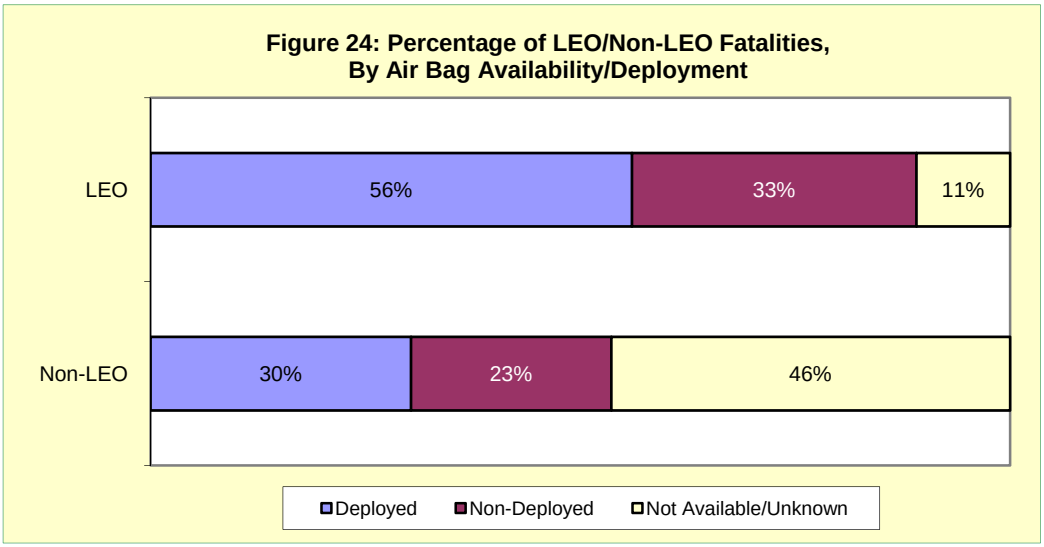
Restraint Use and Air Bag Availability and Deployment

As shown in Figure 23, LEO fatalities used restraint systems more than the non-LEO fatalities. Half of the LEO fatalities used restraint systems and 42 percent did not, while 40 percent of non-LEO fatalities used restraint systems and 52 percent did not.



Source: FARS, NCSA, 2000-2008

As shown in Figure 24, air bags were available for 89 percent of the LEO fatalities, which was 36 percentage points higher than 53 percent of the non-LEO fatalities. Therefore, the LEO fatalities had significantly higher incidence of deployed air bags (56%) and of non-deployed air bags (33%) as compared to non-LEO fatalities, for whom the incidence of deployed air bags were 30 percent and of non-deployed air bags were 23 percent.



The percentages may not add to 100 because of rounding.
Source: FARS, NCSA, 2000-2008

5. Summary

The trend analysis of the LEOKA data showed that the number of law enforcement officers killed by motor vehicle crashes has been increasing since the end of the 1990s. The FARS data also showed a similar trend. This makes the motor vehicle crashes as one of the major causes of fatality of law enforcement officers in the line of duty in the 2000s.

Based on these observations, this study analyzed the FARS data during the period from 1980 to 2008. The characteristics of LEO fatalities in passenger vehicle crashes and motorcycle crashes were studied at the crash, vehicle, and person levels. The LEO and non-LEO groups were compared for the characteristics of fatalities in passenger vehicle crashes, using the FARS data from 2000 to 2008. The two groups showed a substantial difference regarding crash time, first harmful event, roadway function class (rural/urban), roadway surface condition, emergency use, fire occurrence, rollover, most harmful event, impact point, vehicle maneuver, crash avoidance maneuver, age, sex, person type, seating position, restraint use, and air bag availability and deployment.

The findings from this study can be useful in providing guidelines to the law enforcement agencies to address the LEO-related motor vehicle safety issues.

6. References

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[3] NHTSA. (2007). Electronic 2007 FARS Coding and Validation Manual. Publication number 07CV. Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/FARS07CVMan.pdf.

[4] NHTSA. (2009, June). FARS Analytic Reference Guide 1975 to 2008. DOT HS 811 137. Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/811137.pdf.

Appendix

Table A: Number of Law Enforcement Officer Fatalities in Motor Vehicle Crashes, By States[1]				
	1980-1989	1990-1999	2000-2008	Total
California	38	29	40	107
Texas	22	31	28	81
Georgia	18	9	16	43
Tennessee	8	10	15	33
Louisiana	1	6	14	21
North Carolina	3	13	13	29
Illinois	6	9	13	28
Florida	11	12	12	35
Oklahoma	6	1	12	19
New York	16	12	11	39
Alabama	12	13	11	36
Missouri	6	4	11	21
New Jersey	3	3	11	17
Virginia	1	2	11	14
Pennsylvania	10	8	9	27
Indiana	1	9	9	19
Michigan	11	9	7	27
Arizona	9	9	7	25
South Carolina	10	2	7	19
Ohio	5	4	7	16
Kentucky	6	1	7	14
Washington	2	4	5	11
Colorado	2	2	5	9
Nevada	0	2	5	7
Maryland	2	4	4	10
New Mexico	4	1	4	9
Connecticut	1	2	4	7
Montana	2	0	4	6
Massachusetts	4	5	3	12
Minnesota	3	2	3	8
Oregon	5	6	2	13
Wisconsin	4	7	2	13
Hawaii	1	2	2	5
Arkansas	7	3	1	11
Idaho	4	0	1	5
Mississippi	1	2	1	4
West Virginia	1	2	1	4
Utah	0	2	1	3
Vermont	0	0	1	1
Maine	3	2	0	5
Wyoming	1	2	0	3
Iowa	1	1	0	2
Delaware	0	1	0	1
Kansas	1	0	0	1
Nebraska	1	0	0	1
New Hampshire	1	0	0	1
Rhode Island	1	0	0	1
Total	255	248	320	823

[1] States are sorted by the number of law enforcement officer fatalities during 2000-2008.
Source: FARS, NCSA, 1980-2008

Table B: Number of Motor Vehicle Crashes With Law Enforcement Officer Fatalities, By Month				
	1980-1989	1990-1999	2000-2008	Total
January	18	20	24	62
February	17	23	21	61
March	14	23	23	60
April	14	22	19	55
May	28	23	33	84
June	17	12	25	54
July	26	22	31	79
August	18	21	27	66
September	24	15	29	68
October	21	21	37	79
November	19	19	24	62
December	15	12	15	42
Total	231	233	308	772
Source: FARS, NCSA, 1980-2008				

Table C: Number of Crashes With Law Enforcement Officer Fatalities, By Crash Time			
	In Passenger Vehicle	On Motorcycle	Total
8 a.m.-8:59 a.m.	12	4	16
9 a.m.-9:59 a.m.	19	4	23
10 a.m.-10:59 a.m.	16	5	21
11a.m.-11:59 a.m.	19	5	24
Noon -12:59 p.m.	24	8	32
1 p.m.-1:59 p.m.	24	7	31
2 p.m.-2:59 p.m.	23	10	33
3 p.m.-3:59 p.m.	19	13	32
4 p.m.-4:59 p.m.	18	4	22
5 p.m.-5:59 p.m.	17	3	20
6 p.m.-6:59 p.m.	13	6	19
7 p.m.-7:59 p.m.	25	4	29
8 p.m.-8:59 p.m.	33	4	37
9 p.m.-9:59 p.m.	42	1	43
10 p.m.-10:59 p.m.	38	2	40
11 p.m.-11:59 p.m.	56	1	57
Midnight -0:59 a.m.	56	1	57
1 a.m.-1:59 a.m.	51	1	52
2 a.m.-2:59 a.m.	45	1	46
3 a.m.-3:59 a.m.	38	0	38
4 a.m.-4:59 a.m.	37	1	38
5 a.m.-5:59 a.m.	23	0	23
6 a.m.-6:59 a.m.	17	3	20
7 a.m.-7:59 a.m.	17	2	19
Total	682	90	772

Source: FARS, NCSA, 1980-2008

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