

Pedestrian Fatality Characterization in the Mayagüez Metropolitan Area of Puerto Rico

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ABSTRACT

The average pedestrian fatalities in the Commonwealth of Puerto Rico over the last decade represent 31% of all crash fatalities. This trend is similar to the Mayagüez Metropolitan area with 29% of fatalities during the same period. The objective of this study is to characterize pedestrian crash fatalities in the Mayagüez area and its surrounding 8 municipalities. A database was developed using the Puerto Rico Police Department statistics. The important pertinent findings associated with this study showed that the city of Mayagüez has the highest frequency of pedestrian fatal crashes of the region with 42%, of which 68% were male and 32% female, and 44% were over 60 years. Pedestrian fatalities peak hours were between 6:00 PM to 9:00 PM with approximately 34%. Municipality and road segments cross tabulation showed that 26% of the pedestrian fatalities were located between kms 154 to 156 on PR-2 Corridor in Mayagüez with the highest concentration of public residential housing, elementary and high schools and government services on this eight lane urban arterial. The community was divided with a pedestrian bridge constructed approximately 50 years ago which is seldom used by the residents.

Keywords: Pedestrian, Crash, Fatalities, Puerto Rico, Mayagüez

1. INTRODUCTION

Pedestrian fatalities are a mayor concern to government officials of the Highway Traffic Safety Commission of Puerto Rico, the Department of Transportation and Public Works and the Police Department of the Commonwealth of Puerto Rico and to all families and residents of the island. Recent statistics at both local and national level has placed our island in the highest pedestrian fatality rates in the United States with 2.71 per 100,000 populations. During the last decade, pedestrian fatalities represent an average of 31% of all fatalities which is almost 300% as compared to the national figure of 11% in the United States.

Based upon this alarming pedestrian fatality statistic a research study was conducted as part of the Dwight D. Eisenhower Fellowship Program for Hispanic Serving Institutions funded by the Federal Highway Administration with assistance data from the Bureau of Highway Patrol ascribed to the Puerto Rico Police Department and the data of the Highway Safety Commission. This pilot study concentrated on the Mayagüez Metropolitan region and its 9 municipalities. The goal of this study was to identify hazardous pedestrian locations based upon current geometric and operational characteristics that complement the randomness associated with pedestrians. Pedestrian fatalities affects emotionally the family and friends of the victim and creates a comprehensive crash cost of 4 millions dollars per fatality crash depending upon the productivity years that this victim cannot produce to our society and the mental damages and suffering which affects the future family relations at both home an work (HSM, 2010).

2. OBJECTIVES

The main objective is to characterize the pedestrian crash data of the southwest part of the island. In order to achieve the objective the Bureau of Highway Patrol ascribed to the Puerto Rico Police Department was contacted and they provided all the fatal crash records regarding all types of fatal crashes between the periods of 2007 to February of 2013.

Other specific objectives of this investigation were to create a database using the information gathered in the Police Department, developed a comparison between Puerto Rico and the United States with general crash information, generate a general characterization of all types of crash fatalities of the southwest part of the island, identify characteristics of the pedestrian crash fatalities on the southwest part of the island, and finally identifying high frequency pedestrian crash segments in a specific road of the region.

3. METHODOLOGY

The first task performed in the development of this study, was a review of literature regarding pedestrians crash studies in Puerto Rico, various articles regarding pedestrian crashes and the law and regulations apply to pedestrians in the Commonwealth of Puerto Rico. The second task was reviewing all the fatal crash records regarding all types of fatal crashes between the periods of 2007 up to February of 2013 of the 9 municipalities from the region of Mayagüez. The third task was to gather general information regarding fatal crashes in Puerto Rico on the Traffic Safety Commission website, the Fatality Analysis Reporting System (FARS) and the information regarding pedestrian crashes in the United States published by the National Highway Traffic Safety Administration (NHTSA).

The statistical analysis was performed to compare crash data between Puerto Rico and the United States, all types of crash data in the region of Mayagüez and finally statistical analysis for different elements concerning pedestrian crash data in the region. Figure 1 is a flowchart with a summary of the methodology for this study.

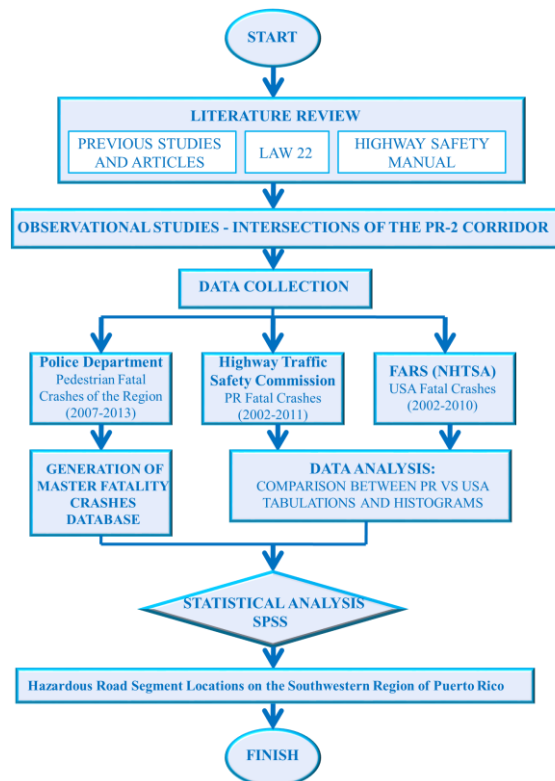


Figure 1: Methodology of the Study

4. RELATED LITERATURE

4.1 RELATED STUDIES AND ARTICLES OF PEDESTRIANS IN PUERTO RICO

The transportation area of the Department of Civil Engineering of the University of Puerto Rico at Mayagüez has conducted two master of sciences thesis regarding pedestrians. One of the investigations was regarding pedestrian behavior on intersections and the other evaluated pedestrians crash data in urban highways. In 2004, Lynnette Alicea submitted a thesis called “Analysis and Evaluation of Crashes Involving Pedestrians in Puerto Rico” (Alicea, 2004). The objective of this particular investigation was to characterize pedestrian crashes in the urban highways of the island. To accomplish the objective Alicea obtained crashes database involving pedestrians, they performed inspections of specific crash sites and did a statistical analysis to compare data between Puerto Rico and United States.

For this research study, Alicea evaluated data from previous years including 1997, 1998 and 2002 from databases provided by the Accident Analysis Office of the Department of Public Works of Puerto Rico and FARS. Based on the results of the statistical analysis this investigation concluded that male pedestrian are three times more susceptible than woman, that young pedestrians of 20 years or younger are more susceptible than older pedestrians to be involved on traffic crashes, elderly pedestrians are more likely to be killed than other age groups, the peak hours of pedestrians crashes are from 6:00 PM to 10:00 PM.

On February of 2013 the local newspaper reported that the pedestrian infrastructure in the island was deteriorated and that of the total crash fatalities 30% involved pedestrians. (Cortés, 2013) This article reported that in many intersections around the island the pedestrians traffic signals were vandalized, the paint of the marked pedestrian crosswalks were deteriorated and that many sidewalks had poor pavement condition. Another article in the same newspaper reported the poor condition of footbridges in the island. (Rivera, 2013) The Department of Transportation and Public Works reported that in the island there are approximately 106 pedestrian bridges and half of them are deteriorated and in need of rehabilitation or reconstruction. Another issue is that many of them do not comply with the American with Disability Act (ADA) since they do not have ramps for disabled users.

4.2 VEHICLES AND TRAFFIC LAW OF THE COMMONWEALTH OF PUERTO RICO

The Vehicles and Traffic Law of the Commonwealth of Puerto Rico (Law #22) was approved on January of 2000. This law basically covers regulations regarding all aspects of vehicles and traffic issues. Chapter 9 includes the regulations concerning pedestrians. This chapter contains three sections including the basic rules, the duties of pedestrians while crossing a public road and the duties of vehicle drivers toward pedestrians.

In terms of the basic rules it dictates that all pedestrians shall obey traffic signals including pedestrian traffic signals. In terms of the duties of the pedestrians while crossing a public road, if they cross out of an intersection, they shall give way to all the vehicles at all time. When crossing intersections they shall use the marked crosswalks provided and cross the street when the pedestrian traffic signal is green. Finally it says that pedestrians shall use sidewalks when provided and if not provided they should walk on the left edge of the road facing traffic. Pedestrians walking reckless and that not follow the regulations can be punished by a fine of \$50.00. If a pedestrian cause a traffic crash can be punished by a \$500.00 fine.

In terms of the drivers duties toward pedestrians, on intersections where there are not traffic lights installed they have to yield by reducing speed or stopping to any pedestrian crossing the street. Finally, drivers shall take precautions to not run over pedestrians. If any of these regulations are violated, drivers are liable to a fine of \$50.00.

5. PEDESTRIAN CRASH ANALYSIS

5.1 PEDESTRIAN CRASH DATA IN PUERTO RICO AND THE UNITED STATES

The pedestrian crash data is collected by the Bureau of Highway Patrol attached to the Puerto Rico Police Department. The data is collected on a monthly basis and it contains statistics on crash fatalities by month, day

of the week, time, region, municipality, age and gender of the victim and the type of victim. The Bureau of Highway Patrol shares the data collected with the Traffic Safety Commission ascribed to the Department of Transportation and Public Works. Table 1 summarizes the data collected in the Traffic Safety Commission website and the information regarding pedestrian crashes in the United States published by the NHTSA.

Table 1: Total Crash Fatalities and Pedestrian Fatalities in PR and USA

Year	Puerto Rico			United States		
	Total Fatalities	Pedestrian		Total Fatalities	Pedestrian	
		Fatalities	Percent (%)		Fatalities	Percent (%)
2002	519	177	34	43,005	4,851	11
2003	495	150	30	42,884	4,774	11
2004	495	162	33	42,836	4,675	11
2005	457	134	29	43,510	4,892	11
2006	508	140	28	42,708	4,795	11
2007	452	145	32	41,259	4,699	11
2008	406	130	32	37,423	4,414	12
2009	365	109	30	33,883	4,092	12
2010	340	101	30	32,885	4,280	13
2011	361	111	31	-	-	-
Total	4,398	1,359	31%	360,393	41,472	11%

In Puerto Rico, the average pedestrian fatalities in the last 10 years represent 31% of the total of all crash fatalities versus 11% in the United States. This statistic should arouse government concern in terms of prioritizing pedestrians while planning. The 111 pedestrian fatalities reported in Puerto Rico in 2011 were an increase of 9.9% from 2010. The 4,280 pedestrian fatalities reported in the United States in 2010 were an increase of 4.6% from the 2009.

Figure 2 is a comparison of a four point moving average of the pedestrian crash fatalities in Puerto Rico and in the United States. On the positive side, both set of data shows a decrease in the pedestrian fatalities. The United States graph has the steepest slope with a slope of -131.3 compare to Puerto Rico that has a slope of -8.

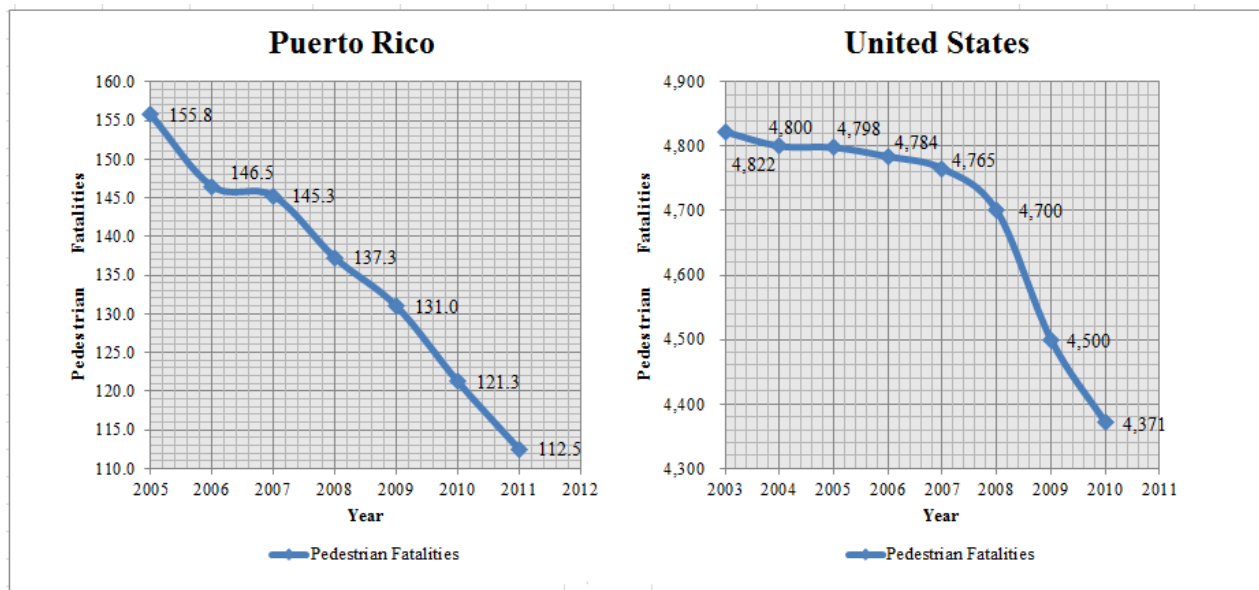


Figure 2: Comparison of Four Point Moving Average on Pedestrian Fatalities in PR and USA

Figure 3 represents a histogram with the states with more pedestrian crash fatalities per 100,000 populations in the United States in the year of 2010. This information was reported by the NHTSA using pedestrian crash fatalities of the year 2010. Puerto Rico has the highest index of 2.71 followed by the state of Florida with an index of 2.58 and Delaware with an index of 2.45.

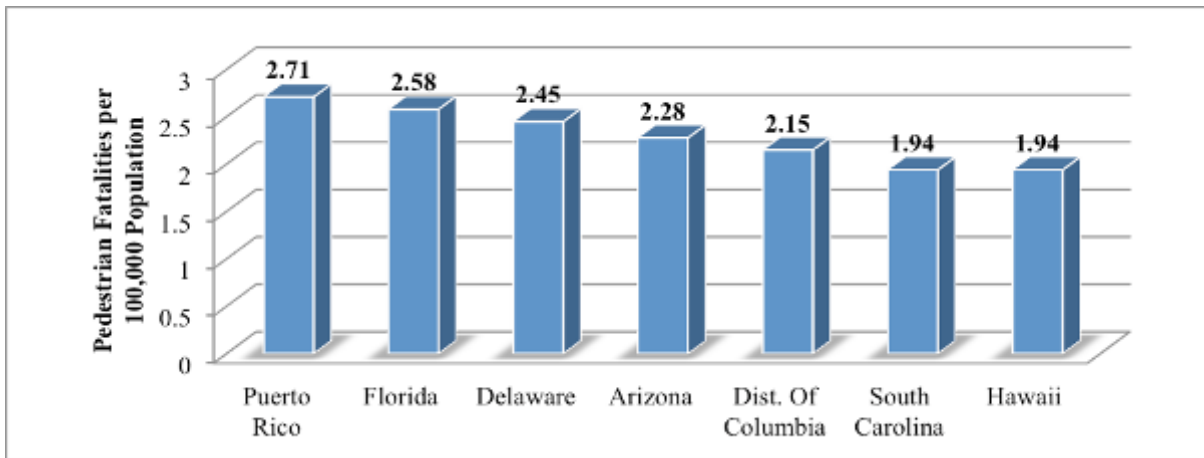


Figure 3: Pedestrian Crash Fatalities per 100,000 Population in the United States (2010)

Specific information regarding crashes in Puerto Rico was obtained in the Accident Analysis Office of the Department of Public Works of Puerto Rico. This office is in charge of collecting all the crash reports provided by the Police Department and developed a database with the information gathered from them. The office has complete crash database from 2002 to 2006 and is working to complete the database for the years 2007, 2008 and 2009.

As part of this research, database with recent crash information of the region of Mayagüez that represents the southwest region of the island of Puerto Rico was developed. The reviewed process of all the crashes reports of the fatally and severe injured from the period of 2007 through 2012 of all crash types including pedestrians lasted for two weeks. Using the crashes reports a database for the region of Mayagüez was created. The next section includes a brief analysis of the crash fatalities of the region.

5.2 CRASH ANALYSIS IN THE MAYAGÜEZ REGION

The Traffic Division of the Bureau of Highway Patrol is the entity in charge of monitoring the principal roads in the different police regions of the island. They have trained and specialized police personal that goes to the scene of the crash and gathers the information using a standardized police crash report (PPR-93). This standardized police report was developed in January of 1988 and it provides a total of 112 elements of data of the crash evaluated.

The crash report is divided in four main parts. The first section describes the exact location, date, time, day of the week, municipality, and the event related the collision and the type of collision. The second section describes the vehicles involved in the collision, name of the driver, address, gender, age and personal information related to the driver, type of vehicle, usage of the vehicle, mechanical defect of the vehicle (if applies) and other general information about the vehicles. The third section describes personal information related to the injured or fatally wounded in the crash and the last section involves a detailed written description and a schematic or drawing of the crash site. Additional, the report had blanks for specific generic codes that are provided within the sections of the report. The Region of Mayagüez of the Traffic Division consists of 9 municipalities of the southwest region of the island. The municipalities are Añasco, Cabo Rojo, Hormigueros, Lajas, Las Marías, Maricao, Mayagüez, Sabana Grande and San Germán.

The region has recorded crash records which include the crash report of the fatal crashes and some records of the severe injured. The total fatal crash reports reviewed were approximately 170. Table 2 summarizes the crash

fatalities data of the region from the period of 2007 through February of 2013, according to the following classification consisting of drivers, passenger, pedestrian, cyclist, motorcyclist and other.

Table 2: Total Crash Fatalities in the Mayagüez Region

Year	Classification of the Fatalities						Totals Fatalities
	Driver	Passenger	Pedestrian	Cyclist	Motorcyclist	Other	
2007	12	6	5	0	3	0	26
2008	8	5	12	2	3	0	30
2009	11	4	11	4	3	1	34
2010	9	3	4	1	3	0	20
2011	12	4	6	0	6	2	30
2012	8	4	10	2	2	0	26
2013	1	1	2	0	0	0	4
Totals	61	27	50	9	20	3	170

During last 6 years, there have been a total of 170 people killed on traffic crashes on the region. The year with the highest number of fatal crashes was 2009. The percentages of the classification of fatalities were 36% of the killed in a crash were drivers, 29% were pedestrians, 16% were passengers, 12% were motorcyclists, 5% were cyclists and 2% were classified as others. The others classification in the table 2 represent a passenger of a motorcycle and two horse riders that were using the road. The 29% percent of the pedestrians killed in this region is consistent with the pattern of the total pedestrians killed in the island which is approximately 30%.

Table 3: Total Crash Fatalities in the Region by Municipality

Year	Municipality								
	Añasco	Cabo Rojo	Hormigueros	Lajas	Las Marias	Maricao	Mayagüez	Sabana Grande	San Germán
2007	4	4	1	3	1	0	10	1	2
2008	4	5	5	1	0	0	8	2	5
2009	3	11	0	3	0	0	13	3	1
2010	2	6	3	0	1	0	4	2	2
2011	5	3	4	3	1	0	11	1	2
2012	3	5	0	4	0	2	9	1	2
2013	0	3	0	0	0	0	1	0	0
Totals	21	37	13	14	3	2	56	10	14

Table 3 represents the municipalities and the total number of fatal crashes that occurred between the periods of 2007 through February 2013. The municipality of Mayagüez had almost 33% of the crash fatalities followed by Cabo Rojo with 22%, Añasco with 12%, Lajas, with 8%, San Germán with 8%, Hormigueros with 8%, Sabana Grande with 6%, and Las Marias with 2% and Maricao with 1%.

5.3 PEDESTRIAN CRASH ANALYSIS IN THE MAYAGÜEZ REGION

The Traffic Division of the Bureau of Highway Patrol has reported 50 pedestrian fatalities from the period of 2007 through February of 2013. Table 4 has a summary of the municipalities of the region, the population of the municipalities reported by the 2010 census and the total pedestrian crash fatalities for each municipality reported for that period. The Municipality of Mayagüez had 42% of the pedestrian fatalities.

Table 4: Total Pedestrian Crash Fatalities in the Region by Municipality

Municipality	Population	Total Pedestrian Fatalities	Percentage (%)
Añasco	29,261	4	8
Cabo Rojo	50,197	14	28
Hormigueros	17,250	3	6
Lajas	25,753	3	6
Las Marías	9,881	1	2
Mayagüez	89,080	21	42
Sabana Grande	25,265	2	4
San Germán	35,527	2	4
Total	282,214	50	100%

The crash report has information related to the age and gender of the victims. Figure 4 shows the information related to the gender and group age of the pedestrian fatalities. In terms of gender, 68% of the victims were male and 32% were female. The pedestrian fatalities age group dictates that almost 44% of the victims were over 60 years old.

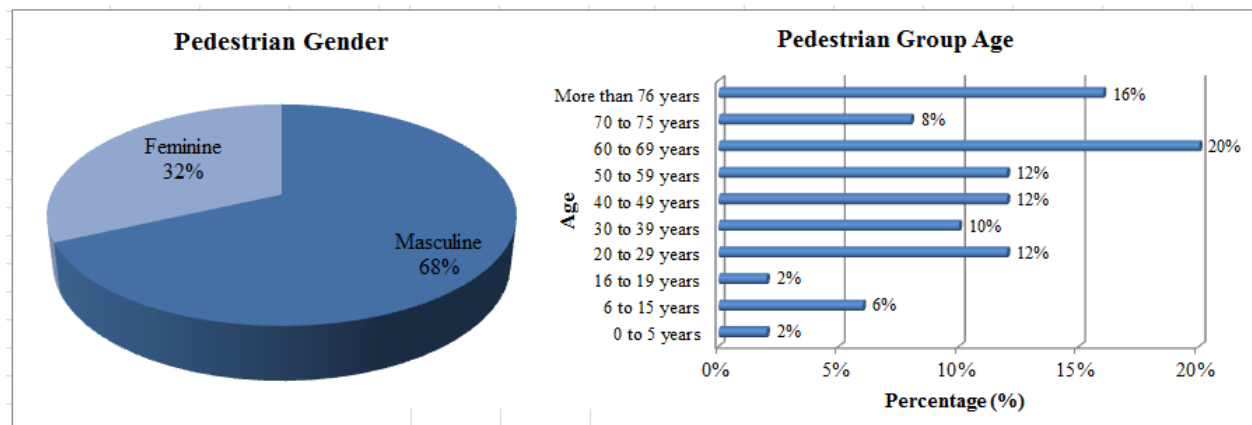


Figure 4: Pedestrian Fatal Crashes – Demographics of the Victims

Another important aspect of pedestrian crash fatalities is the frequency distribution in terms of the month and day of the week of the crash incident. Figure 5 summarizes the information related to month and day of the week of the occurrence of the pedestrian crash. In terms of month, the highest frequency corresponded to the month of July with 16% followed by November with 12%. The rational explanation of the incidence of pedestrian’s crashes during those months might be associated with the fact that Puerto Rico has many holidays during those months.

In terms of the day of the week, Friday has the highest frequency reported with 30%. Of the pedestrian crashes that were reported on Friday, 60% were after 7 PM or during nighttime and 40% were before 7 PM. During the weekend which includes Friday night, Saturday and Sunday the frequency was almost 46% of the pedestrian fatal crashes.

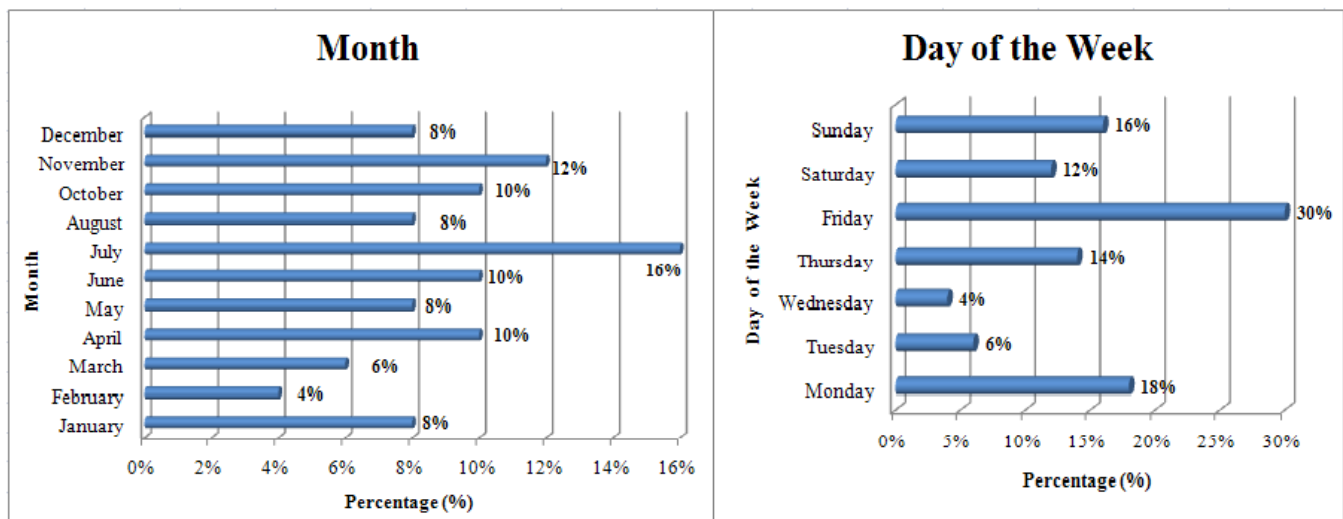


Figure 5: Pedestrian Fatal Crashes – Month and Day of the Week of Crash Occurrence

Figure 6 shows the distribution of number of pedestrian fatalities per hour of the day. Specifically it shows that the top frequency observed was during 7:00 to 8:00 PM with 16% of the total pedestrian fatalities. There are two peak hours, one on early morning (12:00 AM to 4:00 AM) with 24% of the total pedestrian fatalities and the other from the periods of 5:00 PM to 9:00 PM with 38% of the total pedestrian fatalities. Importantly, only 22% of the crashes occurred during daytime and 78% occurred during nighttime.

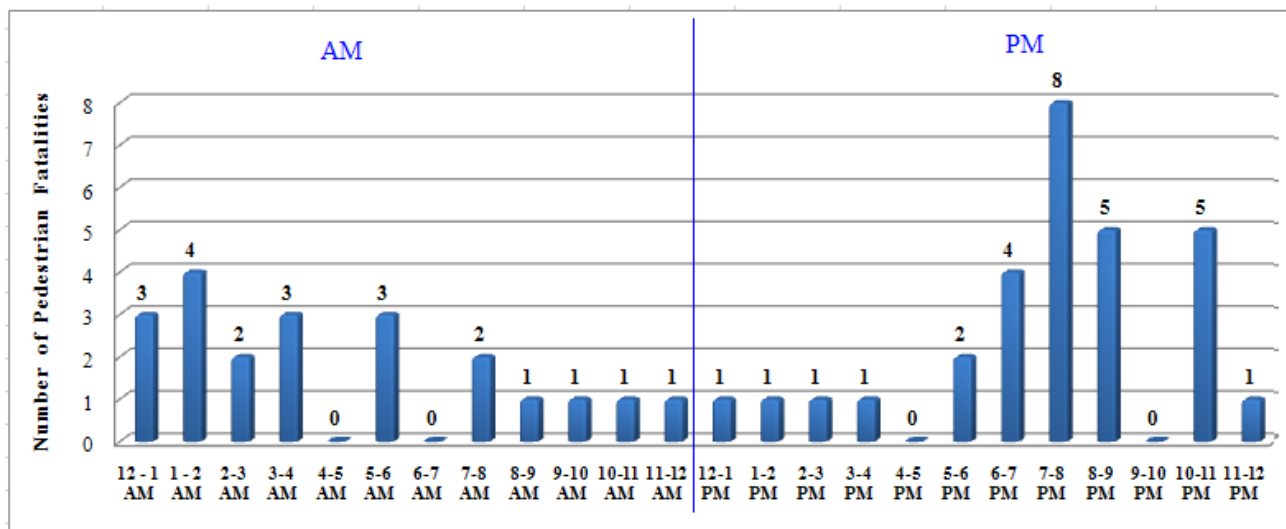


Figure 6: Pedestrian Fatal Crashes by Time of the Day between the periods of 2007 to February 2013

The crash report provides special information related to pedestrians crash sites. The report has many coded elements whose purpose is to make easier the task of gathering information on the scene of a crash. Coded elements such weather condition, illumination on the scene and maneuver of the pedestrians before the crash were reviewed. Narratives with the description of the crash site were also revised.

Figure 7 shows the distribution of pedestrian maneuvers prior to motor – vehicle pedestrian crashes for the period of 2007 through February of 2013. The highest frequency of pedestrian maneuver is crossing outside an intersection with 32%, followed by walking against traffic with 24% and walking in favor of traffic with 15%. Pedestrian behavior contributes to the fatalities because, as this histogram shows, 32% of the persons decided to cross the street outside an intersection or in a mid-segment of a road which is not a safe.

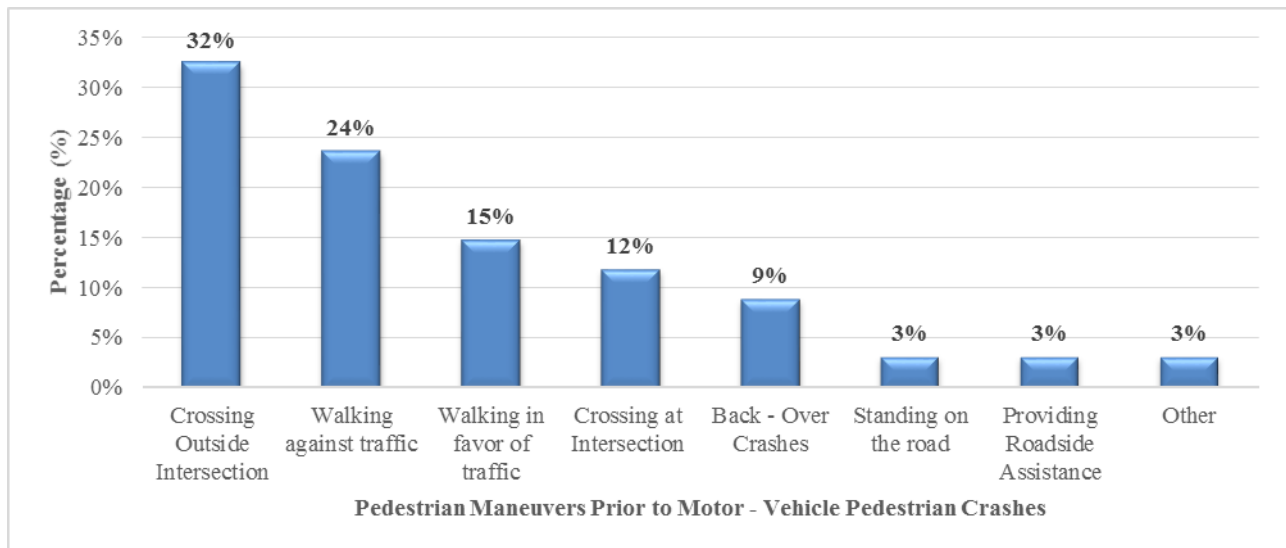


Figure 7: Pedestrian Maneuvers before Motor – Vehicle Pedestrian Crashes

Figure 8 shows the distribution of probable causes of motor vehicle – pedestrian crashes obtained from Police Crash Reports and narratives descriptions prepared by the investigative officer. The highest frequency of probable causes of crashes is the inadequate or absence of illumination on site with 43%.

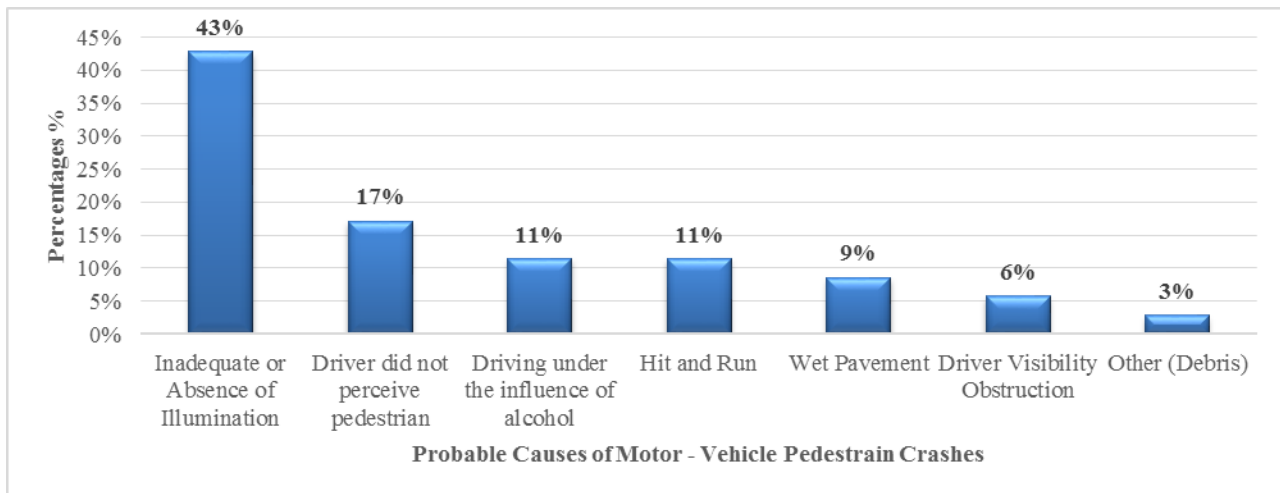


Figure 8: Probable Causes of Motor - Vehicle Pedestrian Crashes

Finally in order to identify a high frequency segment of road or highway, a cross tabulation between municipality and roads was performed and it showed that 26% of the pedestrian fatalities were located on the PR-2 Corridor in the Municipality of Mayagüez. The PR-2 Corridor is classified as an urban arterial with an average daily traffic between 50,000 to 80,000 vehicles per day. A cross tabulation between road and kilometer showed that the highest incidence of pedestrian crashes were between the kilometers 154 to 156 (from the bypass to the Duscombe Street Intersection) on the mentioned Corridor with a frequency of 62% (8 out of 13 crashes) of the total pedestrian crashes of that particular road.

Observational studies performed on the segment between kilometers 154 to 155 showed that on the intersections the medians does not provide refuge to store pedestrians, that the pedestrian walking interval provided was of 12 seconds which were not adequate for a 6 lanes plus two turning lanes that represent a approximately 96 feet. In terms of pedestrian behavior, residents of those communities do not perceive the risks involving crossing the

corridor and the humidity combined with the effort associated with carrying packages avert pedestrians from using the pedestrian bridge located on the mid-section.

6. CONCLUSIONS

In Puerto Rico pedestrian's fatality are almost three times higher than in the United States (31% versus 12%) and also has the highest index (2.71) of pedestrian crash fatalities per 100,000 populations in the United States. In the last 6 years, there have been a total of 170 people killed on a crash site on the region of Mayagüez. The percentages of the classification of fatalities were 36% of the killed in a crash were drivers, 29% were pedestrians, 16% were passengers, 12% were motorcyclists, 5% were cyclists and 2% were classified as others. The city of Mayagüez has the highest frequency of pedestrian fatal crashes with a total of 42%. In terms of gender of the pedestrian crash victims, 68% of the victims were male and 32% were female. The pedestrian fatalities age group dictates that almost 44% of the victims were over 60 years old.

In terms of monthly fatalities, the highest frequency corresponded to the month of July with 16% followed by November with 12%. During the weekend which includes Friday night, Saturday and Sunday the frequency was almost 46% of the total pedestrian fatal crashes. The peak hours for pedestrian fatalities are during nighttime between 6:00 PM to 9:00 PM with approximately 34% of the total pedestrian fatalities. Importantly, only 22% of the crashes occurred during daytime (from 6:00 AM to 6:00 PM) and 78% occurred during nighttime (from 6:01 PM to 5:59 AM). Finally, the cross tab analysis showed that 26% of the pedestrian fatalities were located on the PR-2 Corridor with the highest occurrence of crashes between the kilometers 154 and 156.

7. ACKNOWLEDGMENTS

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