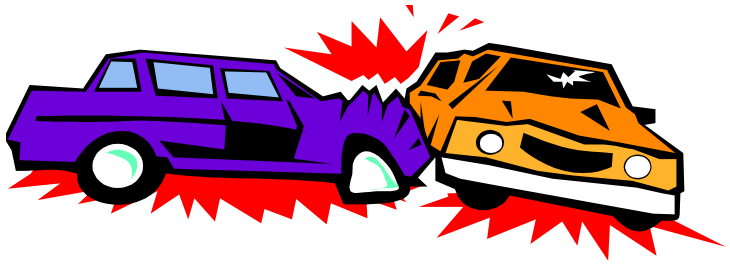
Driver Weight and Automobile Crashes



David DeWolf

MAE 400

Introduction

- See if any trends exist with data
- Determine which groups are at risk
- Give solutions
- What’s new in the automobile industry

Methodology

- Crash data obtained from FARS database
- From 2002 through 2004
- Males and Females
- Restraint type used
- Driver weight
- Age 16 through 65
- Injury severity
- Use Chi^2 to see if an association exists between driver weight and occupant fatality

Results

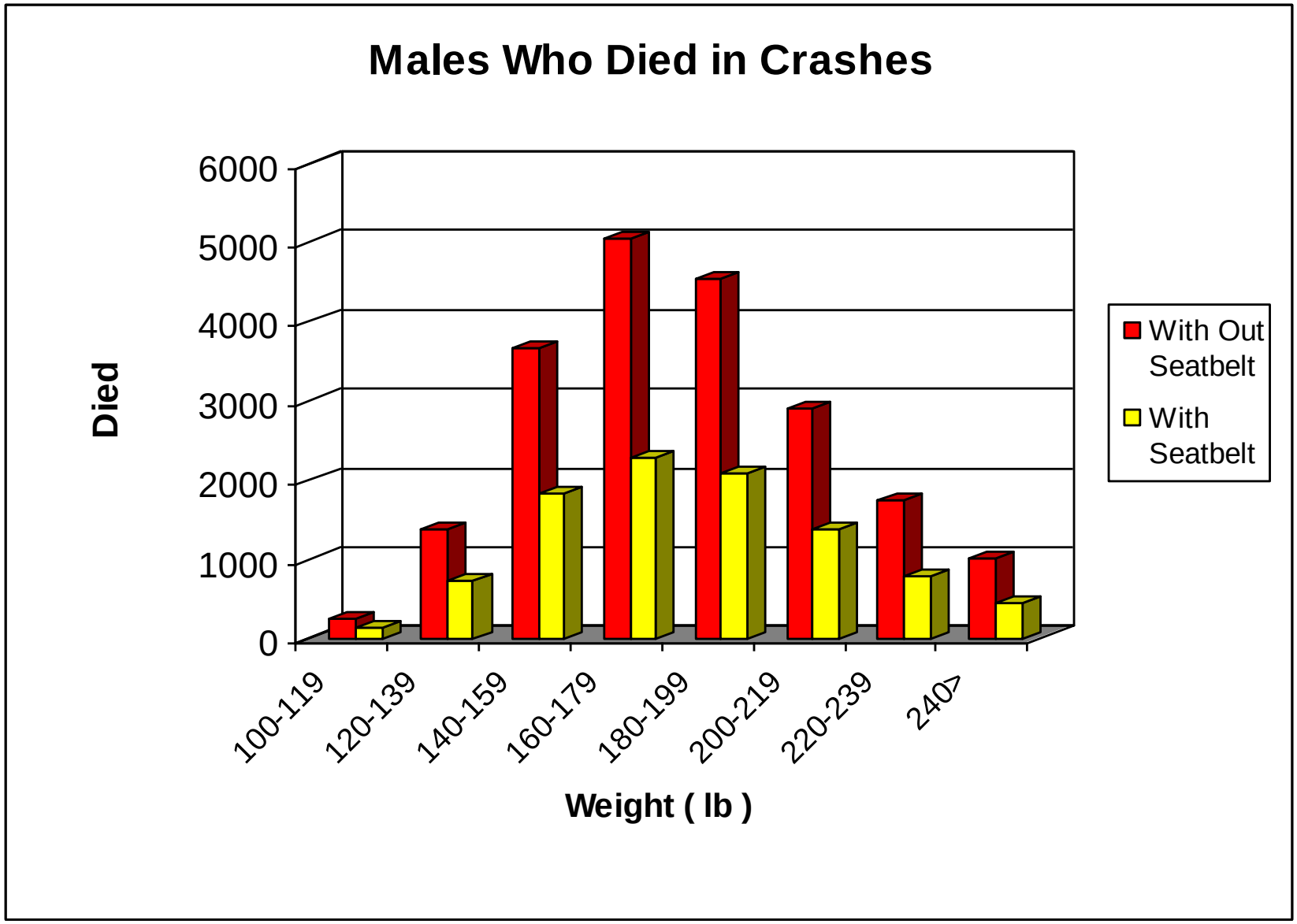


Figure 1

Chi^2

Males Wearing Seatbelt

Observed Data

	DIED	LIVED	Total
>Avg Wt	5071	17858	**22929**
<Avg Wt	4589	11797	**16386**
Total	**9660**	**29655**	**39315**

Expected Data

	DIED	LIVED	Total
>Avg Wt	5633.832888	17295.17	**22929**
<Avg Wt	4026.167112	12359.83	**16386**
Total	**9660**	**29655**	**39315**

$\chi^2 = 178.8$

DOF = 1

C.I. = 0.27-0.36

Males > 170 lbs Are

0.73 Times More Likely To Die

Chi²

Males Not Wearing Seatbelt

Observed Data

	DIED	LIVED	Total
>Avg Wt	10726	3496	**14222**
<Avg Wt	9788	3993	**13781**
Total	**20514**	**7489**	**28003**

Expected Data

	DIED	LIVED	Total
>Avg Wt	10418.53	3803.47	**14222**
<Avg Wt	10095.47	3685.53	**13781**
Total	**20514**	**7489**	**28003**

$\chi^2 = 68.9$

DOF = 1

C.I. = 0.17-0.27

Males > 170 lbs Are

1.25 Times More Likely To Die

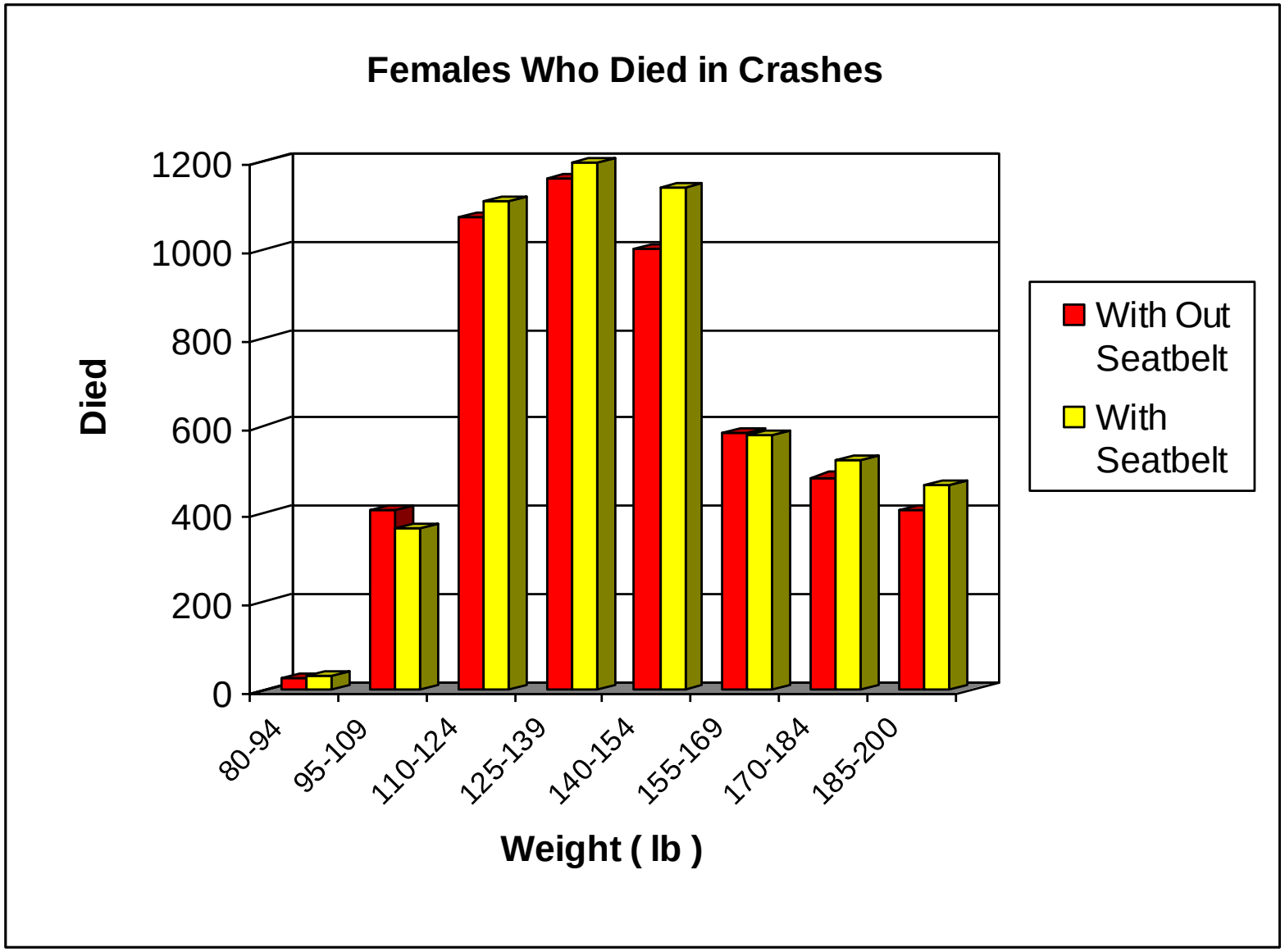

Females Who Died in Crashes
Died
1200
1000
800
600
400
200
0
80-94
95-109
110-124
125-139
140-154
155-169
170-184
185-200
Weight (lb)
With Out Seatbelt
With Seatbelt

Figure 2

Chi²

Females Wearing Seatbelt

Observed Data

	DIED	LIVED	Total
>Avg Wt	3459	7882	**11341**
<Avg Wt	1850	4632	**6482**
Total	**5309**	**12514**	**17823**

Expected Data

	DIED	LIVED	Total
>Avg Wt	3378.184	7962.816	**11341**
<Avg Wt	1930.816	4551.184	**6482**
Total	**5309**	**12514**	**17823**

$\chi^2 = 7.57$

DOF = 1

C.I. = 0.02-0.16

Females > 130 lbs Are

1.1 Times More Likely To Die

Chi²

Females Not Wearing Seatbelt

Observed Data

	DIED	LIVED	Total
>Avg Wt	3216	1149	**4365**
<Avg Wt	1939	606	**2545**
Total	**5155**	**1755**	**6910**

Expected Data

	DIED	LIVED	Total
>Avg Wt	3256.378	1108.622	**4365**
<Avg Wt	1898.622	646.3784	**2545**
Total	**5155**	**1755**	**6910**

$\chi^2 = 5.35$

DOF = 1

C.I. = 0.02-0.25

Females > 130 lbs Are

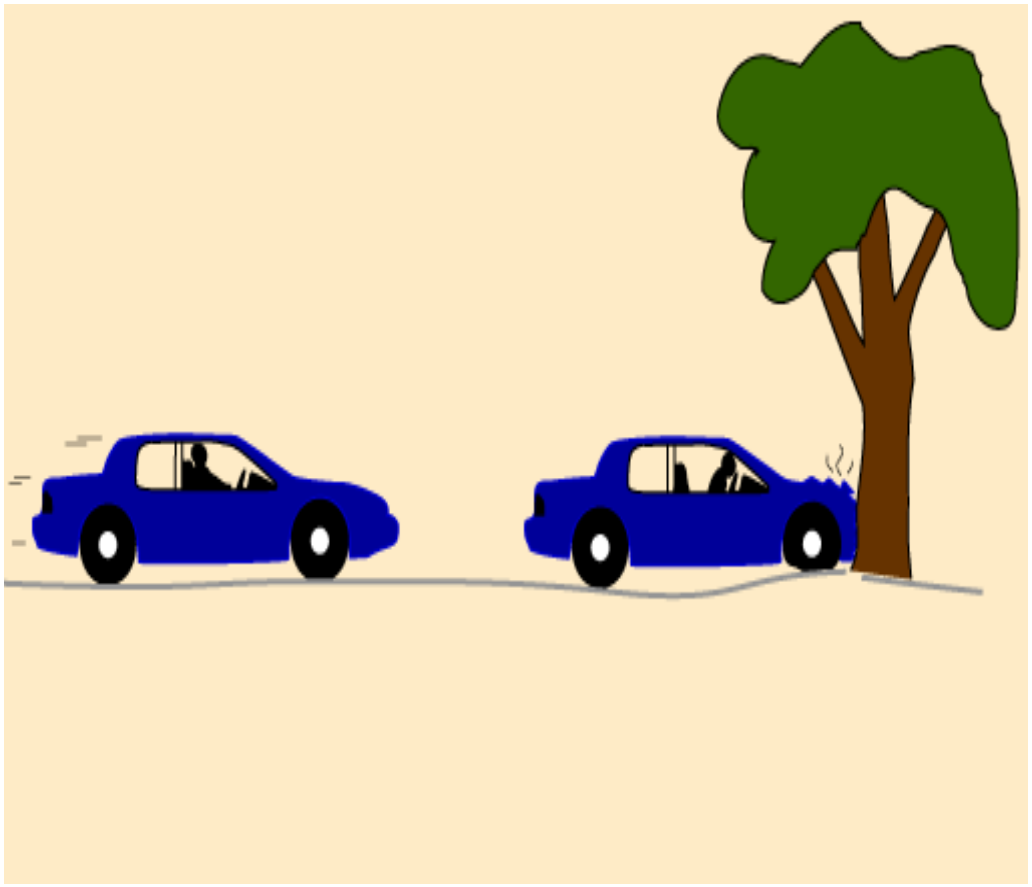
0.88 Times More Likely To Die

Factors That Contribute To Death Toll

- Safety Belt Use
- Weather Conditions
- Lighting Conditions
- Driver Behavior
- Collision Type
- Vehicle Type
- Alcohol/Drugs

Killer Speed

Vehicle Speed not Body Weight Kills



Conservation of Energy

$$Q-W=\Delta KE+\Delta PE+\Delta U$$

$$F = \frac{m\Delta V^2}{2d}$$

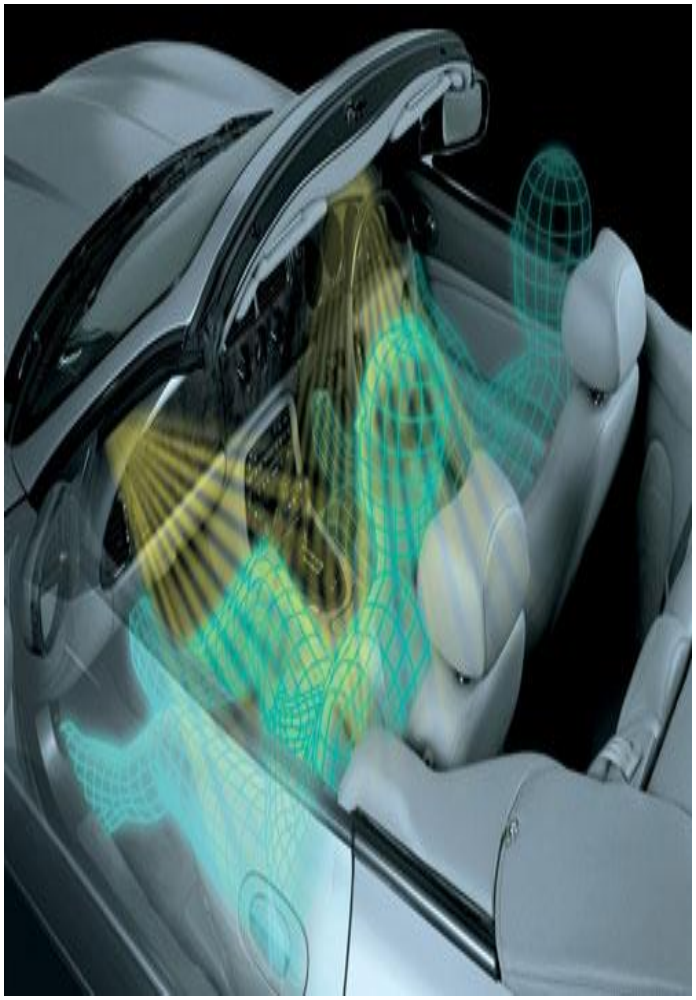
Velocity Dominates

What's New In Design

Honeywell Has New

Securus Fiber Seatbelts

1. **Holds Occupant**
2. **Relaxes Occupant**
3. **Restrains Occupant**



Jaguar Has Adaptive Restraint Technology System (A.R.T.S.)

- Uses Ultrasonic Sensors
- Detects Position and Weight
- Detects Safety Belt Use
- Detects severity of Impact

New Air Bag Designs

- Head Protection
- Rib Cage Protection
- Head Rest
- Knee Protection

Some Problems With Smart “Air Bags”

- Can’t Distinguish From Child to Adult
- Sensors Accidentally Go Off

Conclusion

- Driver Weight Plays Little Role
- Main Factors
  - Speed, Driver Behavior, Weather, Vehicle Design etc..
- Design and Legislation come at a $Price$ and Limit

Questions or Comments?

Driver Weight and Automobile Crashes

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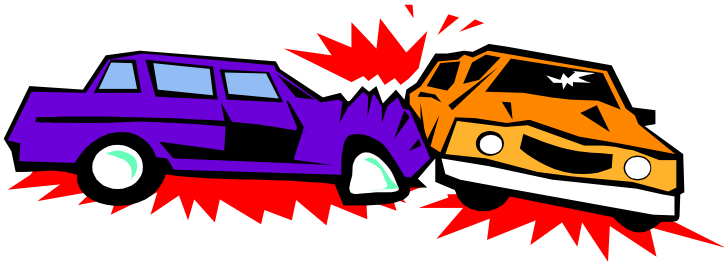

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ABSTRACT

Background: This study examines whether mortality is greater in people who weigh more than the average size person when involved in a motor vehicle crash.

Methods: This study analyzed the effects of driver's weight in vehicle crashes between 2002 and 2004. Variables such as safety belt use, driver weight, gender, injury severity, age, and number fatalities were extracted from the Fatality Analysis Reporting System.

Results: Non- Belted male driver's that weighed more than 170 lbs were killed in twice as many more vehicle crashes than male driver's killed wearing a seatbelt. Male drivers that weighed more than the average male were injured in 33.3% more vehicle crashes than male drivers that weigh less than the average male. Belted Females that weighed more than 130 lbs were killed in 7.6% more crashes than non-belted female drivers

Conclusion: Male's that weigh more than the average male have a higher risk of fatality in a vehicle crash. Females that weigh more than the average female also have a higher risk of fatality in a vehicle crash. Driver weight plays an important role in determining life or death when involved in vehicle crashes, but injuries and fatalities cannot be evaluated on this basis alone. Other factors such speed of vehicles, vehicle types, mismatches in vehicle designs, and collision type are just a few that must also be considered.

INTRODUCTION

According to the Department of Transportation, the total cost to society for injuries related to motor vehicle crashes exceeds $150 billion annually. [1] Several factors contributing to death toll are high speed rates, lack of safety belt use, alcohol, and other driver behaviors. Of all these factors, the driver's body weight is least studied in literature. When grouped according to height and weight as descriptors of body habitus, injury rates for restrained drivers were increased as well as decreased in several subgroups. [2] In this study, we examine the question whether or not a driver's body weight influences their chance of survival in a vehicle crash.

According to a study published in *Accident Analysis and Prevention*, people weighing between 100 and 119 kg (220-262 lbs) are almost two-and-a-half times as likely to die in a crash as people weighing less than 60 kg (132 lbs).[3] Although safety regulations only require the use of 50^{th} percentile male test dummies, virtually all car manufacturers already do crash tests with 95^{th} percentile dummies (6'2" and 223 pounds, or about 188 cm and 100 kg).[4] Studies with new scaled dummy models have shown, that the current standard dummies (5th%ile, 50th%ile, 95th%ile) provide a very limited representation of the real world occupant population. [5]

METHODS

Crash data involving all vehicles were obtained from the Fatality Analysis Reporting System (FARS), developed by NHTSA, for the years 2002 through 2004. The data obtained from the FARS database were confined to genders, safety belt use, driver weight, age, and injury severity.

Both males and females were placed in two different groups which consisted of drivers wearing their seatbelts and drivers not wearing any restraint. The age of all drivers was between 16 years of age to 65. A comparative analysis was performed involving both groups body weight against chance of survival.

The $[chi]^2$ test was used to determine whether an association exists between body weight and occupant fatality. Relative risk (RR) with 95% confidence intervals (CIs) was calculated to determine the magnitude of this association.

RESULTS

After computing the data, a distribution models a bell curve relationship between belted and non-belted males killed in crashes of various weight classes (See Figure 1).

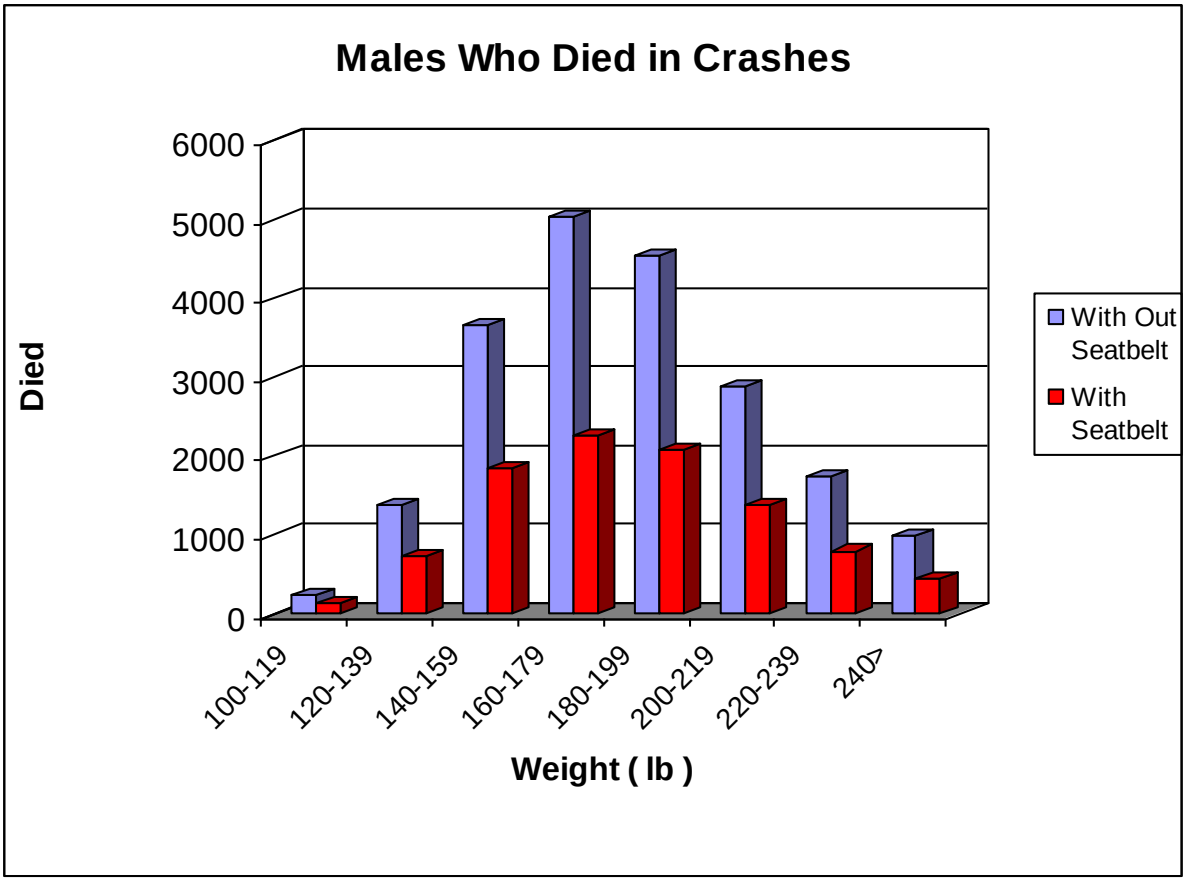

Figure 1

Males that don't wear seatbelts are 2.1 times more likely to die than males that wear seatbelts. Males that weighed greater than 170 lbs of the average size man are 0.73 times more likely to die in crash than males that weight less than 170 lbs when wearing a seatbelt ($p < 0.001$; RR, 0.79; 95% CI, 0.26-0.36). When compared to males not wearing seatbelts, males that weighed greater than 170 lbs of the average size man are 1.2 times more likely to die in crash than males that weight less than 170 lbs when not wearing a seatbelt ($p < 0.001$; RR, 1.06; 95% CI, 0.17-0.28).

Females on the other hand showed a unique relationship between ones that wore a seatbelt and ones that did not (See Figure 2).

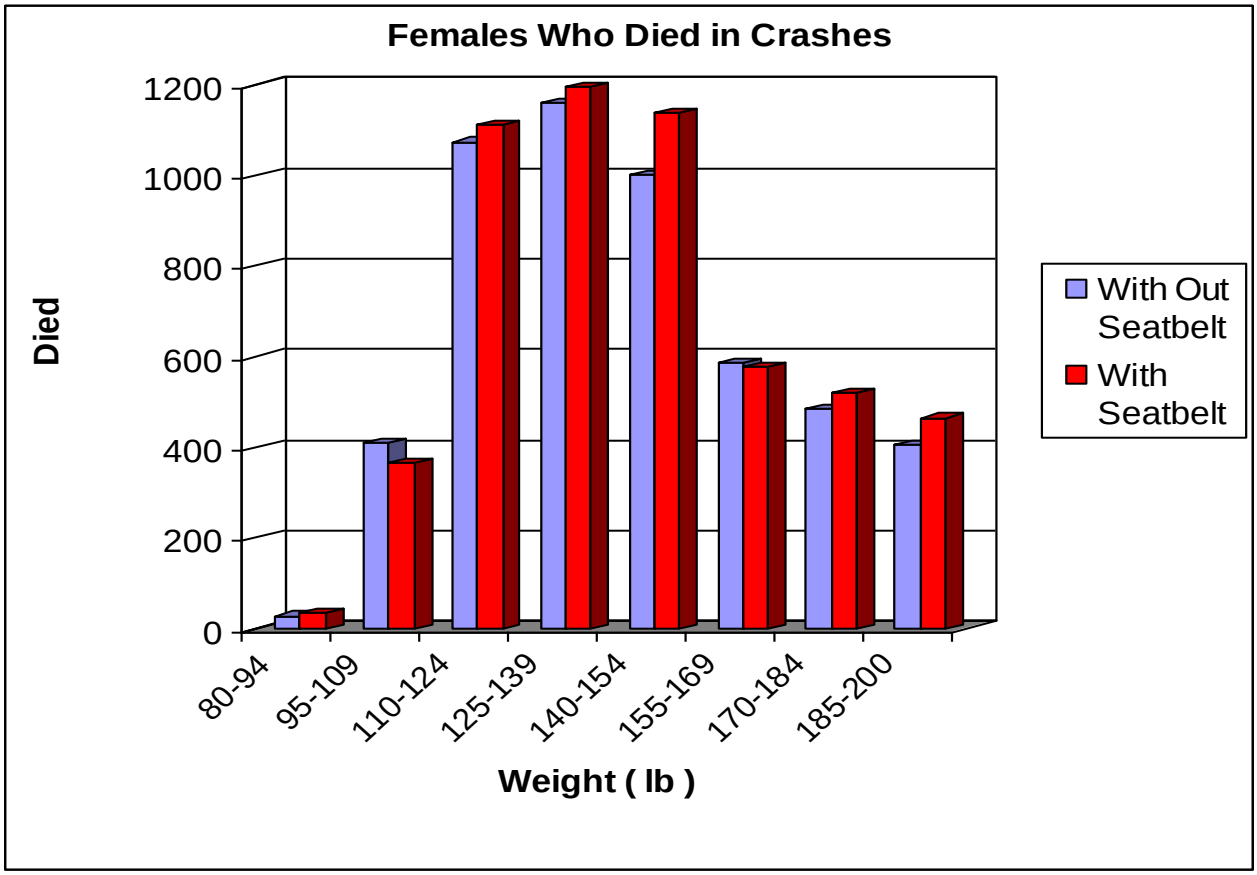

Figure 2

Females that actually wore seatbelts were killed in 262 more crashes than females that did not were seatbelts. Females that weighed greater than 130 lbs of the average size woman are 1.1 times more likely to die in crash than females that weight less than 130 lbs when wearing a seatbelt (p = 0.006; RR, 1.1; 95% CI, 0.027-0.16). When compared to females not wearing seatbelts, females that weighed greater than 130 lbs of the average size woman are 0.88 times more likely to die in crash than females that weight less than 130 lbs when not wearing a seatbelt (p = 0.021; RR, 0.97; 95% CI, 0.02-0.25).

Table 1 list the comparative analysis performed for both males and females comparing driver weight.

Males With Seatbelts								
	2004		2003		2002		TOTALS	
Weight (lb)	Lived	Died	Lived	Died	Lived	Died	Lived	Died
< AVG (170)	4274	1568	4055	1540	3468	1481	11797	4589
> AVG (170	5776	1768	5905	1622	6177	1681	17858	5071
TOTALS	10049	3336	9960	3162	9645	3162	29654	9660
Females With Seatbelts								
Weight (lb)	Lived	Died	Lived	Died	Lived	Died	Lived	Died
< AVG (130)	1729	773	1382	613	1221	572	4332	1958
> AVG (130)	2806	1206	2670	1159	2406	1094	7882	3459
TOTALS	4536	1979	4052	1772	3627	1666	12215	5417
Males With Out Seatbelts								
Weight (lb)	Lived	Died	Lived	Died	Lived	Died	Lived	Died
< AVG (170)	1305	3262	1250	3120	1438	3406	3993	9788
> AVG (170	1212	3579	1253	3728	1031	3419	3496	10726
TOTALS	2517	6842	2503	6848	2469	6825	7489	20515
Females With Out Seatbelts								
Weight (lb)	Lived	Died	Lived	Died	Lived	Died	Lived	Died
< AVG (130)	217	700	177	603	212	636	606	1939
> AVG (130)	363	1026	385	1139	401	1051	1149	3216
TOTALS	581	1726	562	1742	613	1687	1756	5155

Table 1

DISCUSSION

This investigation develops a quantitative relationship for occupant driver weight when involved in a crash. Males have shown a trend which depicts males larger than 170 lbs have a greater chance of dying than males that weighed less than 170 lbs. Females also depict the same trend as the males. It does show that women involved in deadly crash have the same likeliness that they either had a seatbelt on or off. The data collected in this investigation is consistent to an extend with other similar studies which stated heavier people are more likely to be killed or seriously injured in car accidents than lighter people.[3]

CONCLUSION

The findings of this study show that men that weigh more than the average male are more likely to die in an automobile crash. The study also revealed females who weigh more than the average weight woman are also more likely to die in an automobile crash.

More future studies are needed to investigate to why larger people in general die more in crashes than light people. Companies today are testing new products to alleviate the crash forces that occupants endure during a crash. Honeywell developed Securus fibers that are used in seatbelts which it distributes the forces associated with a collision thus lessening the impact on the occupant. [6] Jaguar has developed a new Adaptive Restraint Technology System (A.R.T.S) which uses ultrasonic sensors which detects position and body weight as well as severity of impact. Other companies are developing "smart airbags" which sense such things as body weight, speed at impact, etc., to adjust the force of airbag deployment automatically. [7] These "smart airbag" systems are supposed to detect the size, weight and position of a front-seat passenger to control or stop the airbag's deployment. The problem is that some smart airbags can't tell the difference between a child and a small adult. Others are so sensitive that if a seat cover is installed, the sensor will turn off the airbag. [8]

Driver weight plays a minor role when involved in an automobile crash compared to other outside factors such as speed, driver behavior, weather conditions, lighting conditions, and vehicle design.

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