



Study into Pedestrian Fatality Risk and Engine Size by Adrian Berendt

Summary

We often hear that British roads are among the safest in the world. What we hear less about is that they are no longer getting safer. The United Kingdom is one of just three countries out of 32 European countries where fatalities rose between 2010 and 2019¹. Since 2010, the long-term decline in the number of people killed or seriously injured on Britain's roads has ceased and casualties are increasing once again. Particularly shocking is that 10,000 people out walking or cycling were killed or seriously injured in 2018.

We already know the large part played by speed in the probability of a collision and the seriousness of any consequent injury. We know less about the relationship between injury and vehicle mass. In an article in the Guardian² in 2019, two UK researchers – Adam Reynolds and Robin Lovelace – said *“pedestrians [in the UK were] 70% more likely to be killed if they were hit by someone driving a 2.4-litre engine vehicle than a 1.6-litre model.”* We have tested these conclusions for single vehicle / single pedestrian casualties over a five-year period and found broad agreement. Pedestrians hit by the driver of a car with an engine size **larger than 1800cc are 43 per cent more likely to die than where the engine size is less than 1800cc.**

This increased fatality risk is even higher (50% versus 43%) on roads with speed limits of 40mph or less. This is important because eight out of ten pedestrian casualties occur on those roads.

We acknowledge a number of limitations to the research and recommend further research into whether such correlation also holds for serious injuries, whether the ‘engine size correlation’ extends to vehicle mass and size and whether other factors are at play, such as the profile of drivers of particular vehicle types and whether the marketing of such vehicles is linked to particular driving behaviour.

The two principal conclusions from this study are:

1. Pedestrian fatalities and engine size. Reported pedestrian casualties in single vehicle collisions in the UK from 2014 to 2018³, show a significant positive correlation between the risk of a pedestrian fatality and engine size of the vehicle. For pedestrians, the chance of being killed when hit by a vehicle with an engine size above 1800cc is 43 per cent greater than that of a vehicle below 1800cc.

2. Speed limits. In relation to speed, the correlation holds for fatalities on roads with speed limits of 40mph or less (where 78 per cent of pedestrian fatalities occur) and the risk of a fatality for a pedestrian for vehicles above 1800cc is 50 per cent greater than that of vehicles below 1800cc. Above 40mph, the fatality risk for pedestrians is extremely high and there no apparent correlation with engine size.

¹ <https://etsc.eu/wp-content/uploads/14-PIN-annual-report-FINAL.pdf>

² <https://www.theguardian.com/cities/2019/oct/07/a-deadly-problem-should-we-ban-suvs-from-our-cities>

³ The years when the data was readily available and the volumes easily processed

Introduction

The decline in the number of people killed or seriously injured on UK roads ceased in 2010 and road casualties are increasing once again. Particularly worrying is that vulnerable road users seem to be most at risk – over 10,000 people were killed or seriously injured when walking or cycling in 2018.

A key determinant of the severity of pedestrian injury in a road collision is the force (mass X velocity) impacting on the human body. While the link between speed and injury severity is well documented, research about the relationship with vehicle mass is less extensive. In an article in the Guardian⁴ in 2019 about US research that linked road danger to pedestrians and vehicle size, two UK researchers – Adam Reynolds and Robin Lovelace – were quoted as saying that, “*pedestrians [in the UK were] 70% more likely to be killed if they were hit by someone driving a 2.4-litre engine vehicle than a 1.6-litre model.*” This paper looks at what conclusions can be drawn about pedestrian risk and vehicle size in the UK.

Three limitations to the research are noted:

- 1) Recent casualty reporting changes in the UK⁵ cast doubt on the reliability of serious injury data;
- 2) Data on vehicle weights in road collisions are not publicly available; and
- 3) The paper does not attempt to ascertain whether other underlying factors are at play, such as the profile of drivers of particular vehicle types.

Therefore, this paper concentrates on the fatality risk to pedestrians and uses vehicle engine capacity, as a proxy for vehicle mass.

Further research is needed into the link between pedestrian risk and vehicle makes, models and weight. Such research would be particularly useful to compare with US research showing that more expensive cars were less likely to give way to pedestrians trying to cross the road⁶ and with research that is in progress by Professor Alan Tapp (from the University of the West of England - Bristol) and colleagues on the link between overall road danger and different makes of vehicle.

Research conclusions

1. Pedestrian fatalities and engine size. Reported pedestrian casualties in single vehicle collisions in the UK from 2014 to 2018⁷, show a significant positive correlation between the risk of a pedestrian fatality and engine size of the vehicle. For pedestrians, the chance of being killed when hit by a vehicle with an engine size above 1800cc is 43 per cent greater than that of a vehicle below 1800cc.

2. Speed limits. In relation to speed, the correlation holds for fatalities on roads with speed limits of 40mph or less (where 78 per cent of pedestrian fatalities occur) and the risk of a fatality for a pedestrian for vehicles above 1800cc is 50 per cent greater than that of vehicles below 1800cc. Above 40mph, the fatality risk for pedestrians is extremely high and there no apparent correlation with engine size.

⁴ <https://www.theguardian.com/cities/2019/oct/07/a-deadly-problem-should-we-ban-suvs-from-our-cities>

⁵ Since 2016, about 50% of police forces in the UK have started using a new reporting system – CRASH – to determine whether an injury is ‘serious’ or ‘slight’. This appears to have increased the number of ‘serious’ injuries reported by around 15 – 20% compared with previous years.

⁶ <https://www.iflscience.com/editors-blog/expensive-cars-are-less-likely-to-stop-for-crossing-pedestrians/>

⁷ The years when the data was readily available and the volumes easily processed

Methodology for extracting and filtering data

1. Data source

- DfT records⁸ downloaded for accidents, casualties and vehicles⁹, based on police STATS19 record of reported road incidents with 1 or more casualties.
- Vehicle types (cars, taxis, etc) and casualty types (motorcyclist, car occupant etc), grouped according to TfL classifications.

2. Data selected¹⁰

Source	Data selected
Accidents	Number of vehicles and casualties in each incident and the speed limit
Vehicles	Vehicle type (car, HGV etc) and engine capacity
Casualties	Road user (pedestrian, vehicle occupant etc) and casualty severity

3. Filtering the data

893,000 casualties were recorded on roads in Great Britain between 2014 and 2018, including 119,000 pedestrians (13% of the total).

	No of casualties	Share
0 Pedestrian	118,560	13.3%
1 Cyclist	94,455	10.6%
2 Motorcyclist	94,416	10.6%
3 Car occupant	513,979	57.5%
4 Taxi occupant	14,238	1.6%
6 Bus or coach occupant	24,021	2.7%
7 LGV occupant	22,233	2.5%
8 HGV occupant	6,441	0.7%
9 Other	4,981	0.6%
Grand Total	893,324	100.0%

⁸ <https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data>

⁹ About 100 out of 200,000 records downloaded were deleted where the Accident Index Number was unusable

¹⁰ Other attributes are available

A small number of pedestrians (<7%) are injured in multiple vehicle collisions. Since it is difficult to identify which vehicle caused the injury, these incidents are excluded, leaving 111,000 records.

No of vehicles	No of casualties	Share
1	110,706	93.4%
2	6,660	5.6%
>2	1,194	1.0%
Grand Total	118,560	100.0%

In addition, a single vehicle caused multiple casualties in a few cases (<10%). These have been excluded to avoid skewing the results

Casualties per collision	Number	Share
1	101,305	91.5%
2	8,160	7.4%
>2	1,241	1.1%
Grand Total	110,706	100.0%

In total, these two exclusions represent less than 15% of all pedestrian casualties.

With many vehicle types – bicycles, motorcycles, buses, HGVs, the size of engine lacks the correlation with size / weight that is likely to be the case with cars. Therefore cars, which represent 76% of casualties (77,000 over 5 years) form the basis of this research.

Vehicle subgroup	No of casualties	Share
1 Pedal cycle	1,594	1.6%
2 Motorcycle	3,312	3.3%
3 Car	76,968	76.0%
4 Taxi	5,225	5.2%
6 Bus or coach	4,578	4.5%
7 LGV	6,230	6.2%
8 HGV	2,046	2.0%
9 Other	1,341	1.3%
Grand Total	101,294	100.0%

The final filter excluded 19,700 casualties (26%) where no engine size was recorded on STATS19, leaving 57,000 casualties to be considered.

Engine threshold	Casualties	Share
More than 1800cc	18,125	23.5%
Up to 1800cc	39,102	50.8%
Records analysed	57,227	74.4%
NA	19,741	25.6%
Grand Total	76,968	100.0%

Detailed findings

Of 57,000 casualties where the car's engine size was recorded, **the risk that a pedestrian hit by someone driving a car will die increases with engine size**. Below 1800cc, 1.38% of pedestrian casualties were fatal. Above 1800cc, 1.98% of casualties were fatal - 43% higher.

Applying the same fatality risk for cars with smaller engines to those with larger engine sizes, this could mean 20 fewer pedestrian road deaths per year. This compares with a reduction of only 7 pedestrian road deaths per year from ALL vehicles since 2010.

Pedestrian casualties by engine size and severity in single car collisions 2014-18 (STATS19 data)¹¹

Engine threshold	Detailed engine	Share			No of casualties			Total No of casualties
		Fatal	Serious	Slight	Fatal	Serious	Slight	
Up to 1800cc	1000cc or less	1.37%	24.6%	74.0%	52	935	2,808	3,795
	1001 - 1100cc	1.83%	23.7%	74.4%	4	52	163	219
	1101 - 1200cc	1.37%	25.3%	73.3%	47	869	2,519	3,435
	1201 - 1300cc	1.25%	24.7%	74.1%	67	1,327	3,985	5,379
	1301 - 1400cc	1.44%	23.5%	75.0%	113	1,847	5,892	7,852
	1401 - 1500cc	1.91%	22.4%	75.7%	44	518	1,747	2,309
	1501 - 1600cc	1.31%	23.2%	75.5%	146	2,593	8,419	11,158
	1601 - 1700cc	1.03%	21.7%	77.3%	10	211	752	973
1701 - 1800cc	1.46%	21.3%	77.2%	58	849	3,075	3,982	
Up to 1800cc Total		1.38%	23.5%	75.1%	541	9,201	29,360	39,102
More than 1800cc	1801 - 1900cc	1.66%	23.8%	74.6%	30	430	1,349	1,809
	1901 - 2000cc	1.97%	24.5%	73.6%	197	2,448	7,356	10,001
	2101 - 2200cc	2.09%	23.7%	74.2%	36	409	1,278	1,723
	2201 - 2300cc	1.94%	24.7%	73.4%	10	127	378	515
	2301 - 2400cc	1.24%	21.9%	76.9%	3	53	186	242
	2401 - 2500cc	2.62%	26.3%	71.0%	21	211	569	801
	2501 - 2600cc	0.85%	22.0%	77.1%	1	26	91	118
	2601 - 2700cc	2.22%	23.9%	73.9%	4	43	133	180
	2701 - 2800cc	2.24%	23.3%	74.4%	5	52	166	223
	2901 - 3000cc	2.10%	23.5%	74.4%	35	391	1,241	1,667
	>3000cc	1.92%	22.8%	75.3%	15	178	587	780
More than 1800cc Total		1.98%	24.2%	73.8%	357	4,368	13,334	18,059
Grand Total		1.57%	23.7%	74.7%	898	13,569	42,694	57,161

While the risk of serious injury is also slightly higher for larger engine cars (from 23.5% to 24.2%), this is not statistically significant and may be impacted by the change in reporting method by many police forces for serious injuries.

¹¹ Because of the very small number of casualties (66) where the engine size was between 2001 – 2100cc or 2801 – 2900cc, these have also been excluded

Pedestrian casualties and speed limits

The introduction referred to the mass X velocity equation. While this paper focuses on engine size, the data studied also indicates a correlation between fatality risk and speed limits. More than 90% of all pedestrian casualties that result from being hit by the driver of a car¹² occurred on 20mph and 30mph roads, 1% of those resulted in a fatality, compared with 7% on roads with speed limits of 40mph and above. This positive correlation between the posted speed limit and the risk of a pedestrian fatality in a collision has not been tested for statistical significance.

Pedestrian casualties by speed limit and severity in single car collisions 2014-18

Speed_limit	▼ Fatal	Share			No of casualties			Total No of casualties
		Fatal	Serious	Slight	Fatal	Serious	Slight	
20		0.56%	20.2%	79.2%	38	1,365	5,342	6,745
30		1.02%	21.7%	77.3%	667	14,193	50,590	65,450
40		4.26%	32.6%	63.1%	119	910	1,763	2,792
50		9.68%	35.8%	54.5%	43	159	242	444
60		8.79%	30.8%	60.4%	114	400	783	1,297
70		23.75%	35.8%	40.4%	57	86	97	240
Grand Total		1.35%	22.2%	76.4%	1,038	17,113	58,817	76,968

¹² All engine sizes