Northern Ireland Assembly

Research and Information Service
Briefing Paper

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The role of speed in the frequency and severity of Road Traffic Collisions

1 Introduction

It goes without saying that the speed at which a vehicle is travelling, at the point of impact with a pedestrian, will greatly influence the outcome: at 10-20mph common sense suggests that, injuries sustained would be much less than if the car was travelling at 40-50mph.

This paper draws on a number of studies to present the empirical relationship between vehicle speeds and pedestrian injuries.

2 The impact of speed in collision outcome

The World Health Organisation (WHO) suggest that an increase in average speed of 1 km/h typically results in a 3% higher risk of a crash involving injury, with a 4–5% increase for crashes that result in fatalities.[1] An average speed decrease of 1 km/h leads to a 3% lower risk of an injury accident although this varies dependent on the type of road, According to the European Transport Safety Council:

[1] (WHO) World Health Organisation (2004) Road Safety - Speed [online] available from: http://nia1.me/1wc

- The greatest improvement (from reducing speed) is found on busy urban roads where there is a lot of slow traffic and large speed differences (6% accident reduction per km/h reduction).
- On rural roads, a 1 km/h speed reduction only results in 2% less injury accidents.[2]

The relationship between speed and injury severity is particularly critical for vulnerable road users such as pedestrians and cyclists. For example:

- pedestrians have been shown to have a 90% chance of survival when struck by a car travelling at 30 km/h (18.6mph) or below.
- but less than 50% chance of surviving an impact at 45 km/h (28mph).
- Pedestrians have almost no chance of surviving an impact at 80 km/h (50mph).[3]

2.1 Injury Severity

For pedestrians, the likely severity of injury is typically measured in terms of the speed of the vehicle at the point of impact with the pedestrian; this is often presented in the form of a fatality risk curve[4] such as the one presented below in figure one.[5]

- This curve shows the estimated risk of a pedestrian being killed is approximately 9% if they are hit at a speed of 30 mph.
- The risk at an impact speed of 40 mph is much higher, at approximately 50%.
- This figure also shows that the confidence intervals (the dashed lines in figure 1) get much wider as the impact speed increases.
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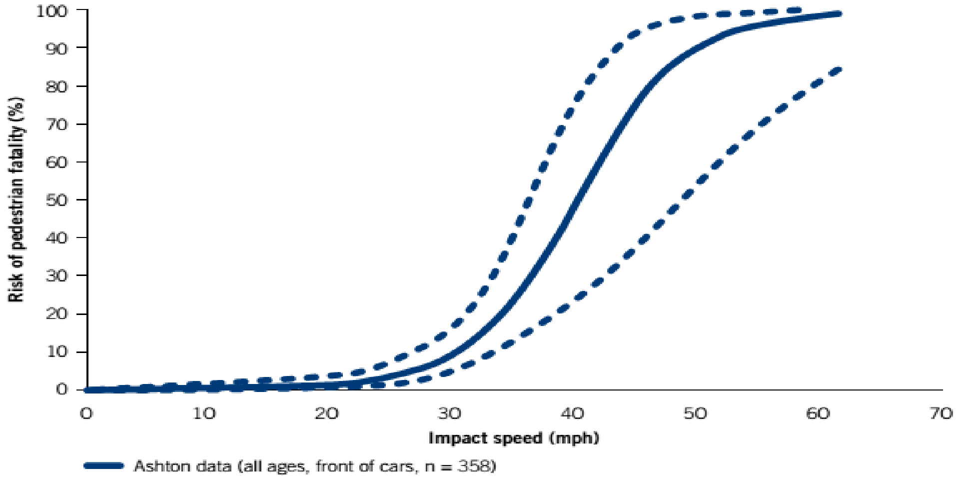
Figure 1: Risk of pedestrian fatality calculated using logistic regression from Ashton and Mackay data



Source: Richards (2010)

[2] (ETSC) European Transport Safety Council (2005) Motor Vehicle Speed in the EU [online] available from: http://nia1.me/1uc

[3] (WHO) World Health Organisation (2004) Road Safety - Speed [online] available from: http://nia1.me/1wc

[4] Kröyer, H.R.G., Jonsson, T., and Várhelyi, A. (2014) 'Relative fatality risk curve to describe the effect of change in the impact speed on fatality risk of pedestrians struck by a motor vehicle'. *Accident Analysis and Prevention* vol. 62 (2014) pp. 143 – 152

[5] Richards, D.C. (2010) Relationship between Speed and Risk of Fatal Injury: Pedestrians and Car Occupants. DfT: London [online] available from: http://nia1.me/1wi

Fatality risk curves provide a strong visual tool, particularly for those advocating lower speed limits as there is a clear correlation between collision speed and outcome. However, curves do vary considerably from study to study and it is therefore necessary to consider the key variables within the population studied and the methodology employed.[6] [7]

Already the two studies presented here, one by the WHO and the other by Ashton and MacKay, clearly demonstrate the differences in outcomes: in the Ashton and MacKay study the chance of survival for pedestrians involved in a collision at 30mph (91%) is significantly better than that reported by the WHO (less than 50% chance of survival at 45km/h (28mph)).

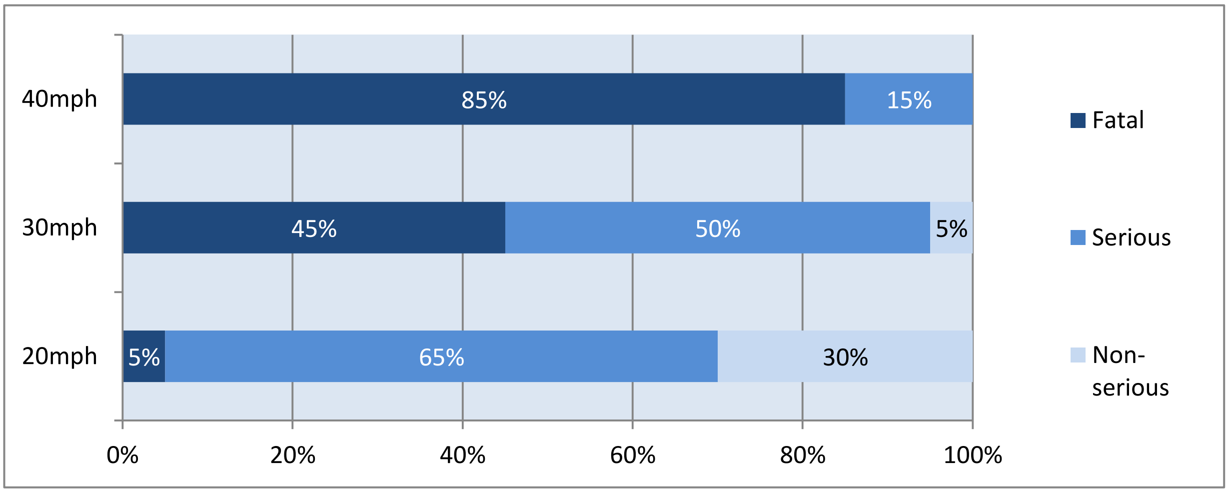
Table one provides fatality risk estimates from eight separate studies ranging over 30 years. The most recent (Cuerben, et al. 2007 and Oh, et al. 2008) again demonstrate the potential for variances in the degree at which risk increases with speed.

In the Cuerden study the fatality risk increases by 10% between 30 and 50km/h (31mph), whereas there is a 27% increase in fatality risk between 30 (18.6mph) and 50km/h identified in the Oh, et al. study.

This difference can be explained by differences to the population studied i.e. the Cuerden study looks at car/pedestrian collisions only while the other Oh study examined collisions involving a range of different vehicles, including trucks and buses, therefore the likelihood of a more serious outcome is to be expected.

Other studies, such as Ashton (1982) have reported even steeper rises in the chance of fatality between 30 and 50km/h i.e. pedestrians have around a 5% chance of fatality at 30km/h rising to 40% at 50km/h (31mph). This is the data range adopted in the UK Department of Transport Traffic Advisory Leaflet 7/93, as shown in figure two.

Figure 2: Vehicle Impact Speed and Pedestrian Injury Severity



[6] Rosen, E., Stigson, H. and Sander, U. (2011) Literature review of pedestrian fatality risk as a function of car impact speed. *Accident Analysis & Prevention Volume* 41, Issue 3, May 2009, Pages 536-542

[7] Kröyer, H., Jonsson, T. and Várhelyi, A. (2014) Relative fatality risk curve to describe the effect of change in the impact speed on fatality risk of pedestrians struck by a motor vehicle. *Accident Analysis and Prevention vol. 62 pp 143 – 152*

Table 1: Years of data collection and fatality risks estimated at 30, 50 and 70km/h in previous publications on the fatality risk for pedestrians struck by passenger cars.[8]

	Years of Data	30km/h (18.6mph)	50km/h (31mph)	70km/h (43mph)
Anderson et al. (1997)[9]	1978	8%	85%	100%
Ashton (1982)[10]	1965-1979	≈5%	≈45%	≈95%
Pasanen (1992)[11]	1965-1979	6%	40%	94%
Yaksich (1964)	1958-1963	≈22%	≈65%	100%
Cuerden et al. (2007)[12]	2000-2007	≈2%	≈12%	≈33%
Davis (2001)*[13]	1965-1979	1%	7%	51%
Hannawald and Kauer (2004)	1991-2003	4%	14%	39%
Oh et al. (2008)**[14]	2003-2005	7%	34%	77%

*Risk estimates regard pedestrians in the ages of 15-59
** Striking vehicles include passenger cars, SUVs, vans, trucks, and buses

In general it can be concluded that although the absolute values of risk differ between most datasets, the increase in fatality risk with impact speed follows a similar pattern:

- There is a slow gradual rise of risk up to impact speeds of 20mph;
- In some cases this slow gradual rises continues up to 30mph;
- Although in some cases the rise in fatality risk is marked between 20 and 30 mph;
- In almost all cases the risk of fatality increases most rapidly above speeds of 30mph.

3 Other factors in IRTC outcomes

When a road traffic collision involving a car and a vulnerable road user does happen, the speed of the vehicle at impact, though critical, is only one of a number of variables that will have a bearing on the severity of injury. Other important factors include:

- factors related to the casualty (age, gender, biomechanical tolerance);
- factors related to the vehicle (size shape, impact speed); and
- factors related to the wider environment (characteristics of the object hit, effectiveness of the medical treatment, etc.).

[8] Rosen, E. and Sander, U. (2009) Pedestrian fatality risk as a function of car impact speed. *Accident Analysis and Prevention* vol. 41 pp. 536–542

[9] Anderson RWG, McLean AJ, Farmer MJB, Lee BH, Brooks CG (1997) 'Vehicle travel speeds and the incidence of fatal pedestrian crashes', *Accident Analysis & Prevention*, 29(5), pp 667-674.

[10] Ashton, S.J., 1982. A preliminary assessment of the potential for pedestrian injury reduction through vehicle design. SAE, Technical Paper 801315.

[11] Pasanen, E. (1992) Driving Speeds and Pedestrian Safety; A Mathematical Model. Helsinki University of Technology.

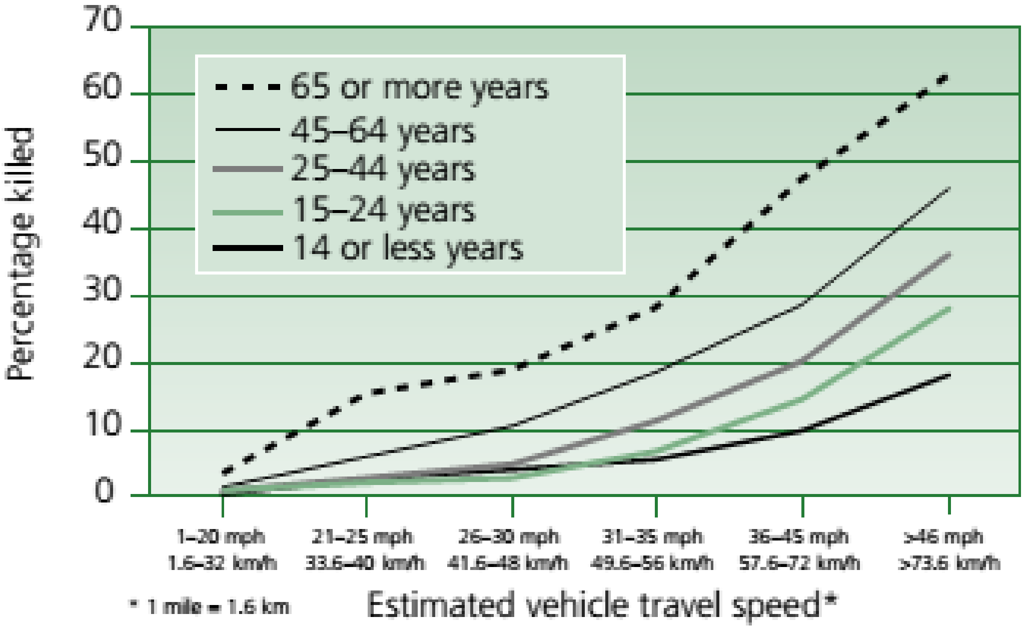
[12] Cuerden, R., Richards, D., Hill, J., (2007). Pedestrians and their survivability at different impact speeds. In: Proceedings of the 20th International Technical Conference on the Enhanced Safety of Vehicles, Lyon, France, Paper No. 07–0440.

[13] Davis, G.A. (2001) Relating severity of pedestrian injury to impact speed in vehicle pedestrian crashes. Transport Res Rec. Record No. 1773, 108–113.

[14] Oh, C., Kang, Y.S., Youn, Y., Konosu, A., 2008b. Assessing the safety benefits of an advanced vehicular technology for protecting pedestrians, *Accident Analysis and Prevention*. Vol. 40, pp. 935–942.

Figure seven shows how the chance of being killed during a road traffic collision increases according to the age of victims and vehicle impact speed. This shows that a 65 year old involved in an accident at any speed has a significantly higher chance of fatality than any other age group. Those aged 14-24 have the lowest chance of fatality – less than 10% up to speeds of 30mph or 49.6km/h. Indeed younger age cohorts appear to have a much higher chance of survival even at speeds up 46mph.

Figure 7: Estimated fatality risks at various speeds and age cohorts



4 Stopping distances

As the speed of a vehicle decreases, the distance required for it to come to a complete halt also decreases. This means that it a driver travelling at 20mph will be able to stop their vehicle more quickly than a driver travelling at 30mph could.

The time needed to respond to a hazard e.g. a child stepping out from behind a car, comprises two elements:

- driver reaction time; and
- braking distance.

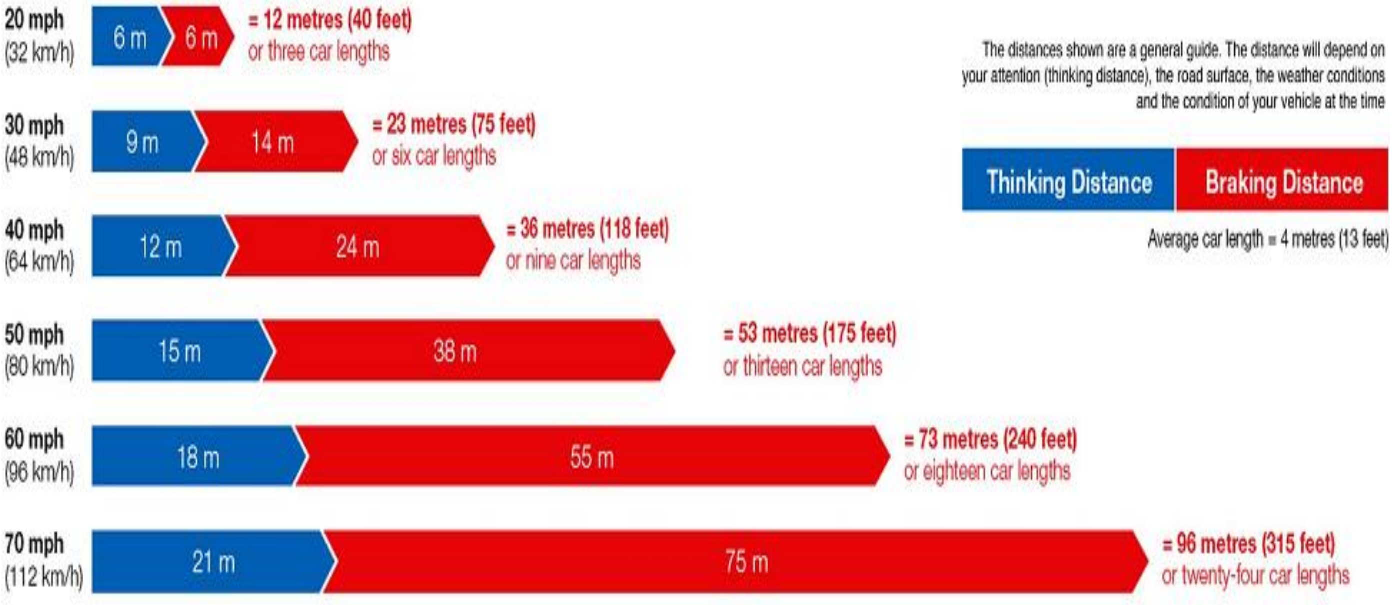
Driver reaction time, typically one second in standard conditions,[15] is the distance travelled in proportion to the speed and the braking time. Braking distance is proportional to the square of speed (v^2) so the distance between starting to brake and coming to a complete stop greatly increases with speed (see Figure 8).[16] Consequently the possibility of avoiding a collision reduces as speed increases.

[15] The Official Highway Code of Northern Ireland
[16] Ibid.

Again speed is only one factor: the attention being paid by the driver (thinking distance), the road surface, the weather conditions and the condition of the vehicle at the time will all become a factor.

That being said, figure four shows that in normal conditions the stopping distance at 20mph (40 feet) is less than half the stopping distance would be at 30mph (75 feet).

Figure 8: Vehicle stopping distances



Source: The Official Highway Code of Northern Ireland