ELSEVIER

Accident Analysis and Prevention 38 (2006) 215–224

ACCIDENT ANALYSIS & PREVENTION

www.elsevier.com/locate/aap

Driving speed and the risk of road crashes: A review

Letty Aarts *, Ingrid van Schagen

Institute for Road Safety Research SWOV, Duindoorn 32, 2260 BB Leidschendam, Netherlands

Received 15 April 2005

Abstract

Driving speed is an important factor in road safety. Speed not only affects the severity of a crash, but is also related to the risk of being involved in a crash. This paper discusses the most important empirical studies into speed and crash rate with an emphasis on the more recent studies. The majority of these studies looked at absolute speed, either at individual vehicle level or at road section level. Respectively, they found evidence for an exponential function and a power function between speed and crash rate. Both types of studies found evidence that crash rate increases faster with an increase in speed on minor roads than on major roads. At a more detailed level, lane width, junction density, and traffic flow were found to interact with the speed–crash rate relation. Other studies looked at speed dispersion and found evidence that this is also an important factor in determining crash rate. Larger differences in speed between vehicles are related to a higher crash rate. Without exception, a vehicle that moved (much) faster than other traffic around it, had a higher crash rate. With regard to the rate of a (much) slower moving vehicle, the evidence is inconclusive.

Keywords: Driving speed; Speed variance; Crash rate; Literature review

1. Introduction

Speed is an important factor in road safety. Speed not only affects the severity of a crash, but is also related to the risk of being involved in a crash (e.g. Elvik et al., 2004). Once a crash occurs, the relationship between speed and the outcomes of a crash is directly related to the kinetic energy that is released during a collision ($E_k = (1/2)mv^2$) and hence quite straightforward. The relationship between speed and the risk of a crash is much more complex. It is easy to understand that at high speeds the time to react to changes in the environment is shorter, the stopping distance is larger, and manoeuvrability is reduced. However, it is difficult to quantify this relationship unequivocally, since many factors determine to what extent these consequences of a higher speed would affect the crash rate. There are quite a few empirical studies that looked into the speed–crash rate relationship aiming at quantifying the general relationship and the influence of external factors. They often used different research methods as well as different speed measures, which complicates a direct comparison of the results and the understanding of different outcomes. It is the objective of the current review to present and discuss a number of these empirical studies in a systematic way to disentangle the factors that may be responsible for differences in the outcomes, come to a balanced judgement of the most likely conclusions, and, finally, to identify issues that are as yet insufficiently clear and would benefit from further research. The emphasis is on recent studies, but also a small number of older studies with influential results are discussed.

2. Absolute speed and crash rate

Many of the studies into the relationship between speed and crash rate examined absolute speed or found absolute speed to be relevant for crash rates. Some of these studies looked at individual vehicle speeds, others at average road section speeds (Table 1).

2.1. Individual vehicle speed

One way to examine the relationship between speed and crash rate, is to determine the crash liability of individual

* Corresponding author. Tel.: +31 70 317 33 79; fax: +31 70 32 012 61.
E-mail address: letty.aarts@swov.nl (L. Aarts).

0001-4575/$ – see front matter © 2005 Published by Elsevier Ltd.
doi:10.1016/j.aap.2005.07.004

Table 1
Absolute speed and crash rate

Study	Method	Crash measure	Road type(s)	Number of cases	Origin of data	Results
Individual vehicle speed						
Fildes et al. (1991)	Self-report study	Material damage only or more severe in last 5 years	Urban 60 km/h and rural 100 km/h (speed limits). Data of V15 and V85 on each road were used	707 drivers, four road links, two types of roads	Australia	Exponential functions per road type (not specified): the higher the speed, the larger the increase of the crash rate
Maycock et al. (1998)	Self-report study	Material damage only or more severe in last 3 years	All UK road types (not specified; average speed = 52 mph (≈83 km/h))	6435 drivers, 43 road links	UK	$A_{i3} = 0.265\left(\frac{v}{\bar{v}}\right)^{13.1}$
Quimby et al. (1999)	Self-report study	Material damage only or more severe in last 3 years	All UK road types except for highways (not further specified; average speed = 42 mph (≈67 km/h))	4058 drivers with free speed, 24 road links	UK	$A_{i3} = 0.215\left(\frac{v}{\bar{v}}\right)^{7.8}$
Kloeden et al. (1997, 2002)	Case–control study	Hospital admission or more severe	Urban roads, 60 km/h (speed limit)	151 cases, 604 controls	Australia	Urban roads with speed limit of 60 km/h: $I_r = \exp(0.1133374\Delta v + 0.0028272v^2)$
Kloeden et al. (2001)	Case–control study	Hospital admission or more severe	Rural roads, 80–120 km/h (speed limit)	83 cases, 830 controls	Australia	Rural roads with speed limits of 80–120 km/h: $I_r = \exp(0.07039\Delta v + 0.0008617v^2)$
Average speed at road section level						
Nilsson (1982, 2004)	Before–after study	Police reported crashes of different severities	90–110 km/h (speed limit)	–	Sweden	Crash rate: $A_2 = A_1\left(\frac{v_2}{v_1}\right)^2$, injury rate: $I_2 = I_1\left(\frac{v_2}{v_1}\right)^3$, fatality rate: $F_2 = F_1\left(\frac{v_2}{v_1}\right)^4$
Finch et al. (1994)	Meta-analysis of before–after studies	–	30–120 km/h (speed limit)	13 studies for fitting the model (but more studies are discussed)	Finland, United States, Switzerland, Denmark	$\Delta A = 4.92\Delta\bar{v}_{\text{mph}}$ and $\Delta A = \left[\frac{53.40}{1+\exp(-0.58\Delta\bar{v}_{\text{mph}})}\right] - 25.09$
Baruya (1998a, 1998b)	International cross-sectional study	–	Rural single carriageway roads, 70–110 km/h (speed limit)	171 road links	Sweden, UK, The Netherlands	$A_r = (C_{\text{road}})\bar{v}^{-2.492}o_{v_{\text{limit}}}^{0.114}$ with $C_{\text{road}} = 5.663\text{fl}^{0.748}l^{0.847}\exp(0.038j - 0.056w + 0.023v_{\text{limit}})\exp(0.023v_{\text{limit}})$