To:	Transport & Health Policy Makers, & Practitioners
From:	Prof Adrian Davis, TRI, Edinburgh Napier University
Date:	December 12th November 2023
Subject:	Essential Evidence 4 Scotland No.77 Nillson's Power Model: Highway Speed and Highway Safety

Top line: Nillson's Power Model was one of the first to enable researchers to forecast changes in crash injury prevalence with changes in speed and speed limits – on non-urban, higher speed limit roads.

Speed produces kinetic energy, which is transformed into deformation of vehicles, biomechanical energy, and heat during a crash. The amount of energy interchange can result injury severity that is equal to one half of the vehicle mass multiplied by the square of the vehicle speed.[1] The amount of kinetic energy is directly proportional to the speed. The larger the amount of kinetic energy, the more destructive a crash will be. Speed, therefore, directly influences crash and injury severity.[2]

Numerous studies, across many countries, have evaluated the injury outcomes of changes in prevailing speed limits, both urban and rural. Almost invariably, fatalities and serious casualties have fallen when speed limits have been lowered and have increased when speed limits have been raised. On interstate highways in the United States, for example, the limit was reduced in the 1970s, restored to its original level in the late 1980s then further increased, in numerous states, in the mid to late 1990s. Fatalities fell, rose, and then rose again correspondingly.[3]

Nilsson was one of the first researchers to develop a model to describe the relationship between speed and highway safety. He developed the so-called power model of the relationship between speed and highway safety.[4] Nillson's relationships were empirically derived based on speed changes and crash effects resulting from a large number of rural speed limit changes. At all three severity levels were consistent with his power model. The model has its main use as a forecasting model and gives an answer to the question: "What will happen regarding safety if the average speed is changed by x% from the existing speed level and everything else remains unchanged"?[5]

Nillson's Power Model has led to greater analysis of the impact of speed change on collisions and injury severity: it showed, for example, that a 5% increase in average speed leads to approximately a 10% increase in all injury crashes and a 20% increase in fatal crashes. The same research indicates the positive impacts of reducing vehicle speeds: A 5% decrease in average speed leads to approximately a 10% decrease in injury crashes and a 20% decrease in fatal crashes. In 2004 Nilsson noted that there had been very few crash investigations of the changes in speed limits in urban areas, 2010, Cameron and Elvik in assessing Nillson's Power Model concluded that it does not appear to be directly applicable to traffic speed changes on urban arterial roads.[6]

[1] Khorasani-Zavareh, D. et al 2015 Kinetic energy management in road traffic injury prevention: a call for action, *Injury and Violence*, 7(1): 36-37.
[2] Elvik, R. 2012 Speed limits, enforcement, and health consequences, *Annul Review of Public Health*, 33: 225-238.
[3] Johnston, I. 2004 Reducing injury from speed related road crashes, *Injury Prevention*, 10: 257-259.
[4] Nillson, G. 1981 The effects of speed limits on traffic accidents in Sweden. In: Proceedings, International symposium on the effect of speed limits on traffic crashes and fuel consumption, Dublin. OECD, Paris
[5] Nillson, G. 2004 "Traffic safety dimensions and the Power Model to describe the effect of speed on safety". Bulletin 221, Lund Institute of Technology, Department of Technology and Society, Traffic Engineering, Lund, Sweden. Microsoft Word - Bulletin 221.4.doc (lu.se)/.
[6] Cameron, M., Elvik, R. 2010 Nilsson's Power Model connecting speed and road trauma: Applicability by road type and alternative models for urban roads, *Accident Analysis and Prevention*, 42: 1908-1915.