



To: Place Directorate
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Subject: Essential Evidence on a page: Kinetic Energy Management, Haddon's Matrix, and Road Safety

Top line: Taking a system approach to road traffic injury prevention, road traffic injury is the result of energy transfer. Understanding the role of kinetic energy is important for all stakeholders in road traffic injury preventive activities.

In the concept of road traffic injury (RTI), mass and speed are properties of all the energy that can be transferred during a crash; and the two properties are connected to kinetic (mechanical) energy. 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 As researchers have noted, this means that the kinetic energy during a collision greatly increases due to velocity rather than mass and consequently, small increases in vehicle speed will result in major increases in the risk of injury.²

Speed plays the most critical role in RTIs. In addition, the extent of bodily injury also depends on the shape of the objects involved and their rigidity as well as on what safety equipment is available. This is why kinetic energy management needs to focus more on speed, which can be an important implication in RTIs prevention. If a pedestrian is hit by a vehicle traveling at less than 30 km/h, the risk of bodily injury will be less than 10%, but this rises to about 50% if the vehicle is traveling at 45 km/h.¹

In the 1970s Haddon's suggestion that injury prevention depended on controlling the agent---energy led him to develop strategies later applied to preventing RTIs. Haddon developed a two-dimensional matrix (The Haddon Matrix) to help conceptualize an injury event.³ This framework for analysis makes possible identification of factors related to the host, agent, and environment within the three phases before, during, and after the crash that might be explanatory and contribute to injury prevention strategies. Haddon proposed a series of countermeasures to reduce damage produced by energy transfer applicable across a range of subject areas (eg surgery, weather events, RTIs).⁴ This starts from the prevention of the marshalling of energy in the first place, the second strategy is to reduce the amount of energy marshalled, then thirdly to prevent the release of energy, and so on in avoiding or mitigating energy transfer. A guiding principle of injury control that emerged from Haddon's work was that effective injury control relied on a combination of intervention strategies. Estimates suggest that, in the US, federal motor vehicle safety standards resulting from application of Haddon's energy exchange management approach saved an estimated 328,551 lives during 1960--2002.⁵ Haddon's Matrix has been applied to Transport for London's Road Safety Action Plan for London 2020⁶.

¹ Global Road Safety Partnership. 2008 Speed management: a road safety manual for decision-makers and practitioners.

² Khorasani-Zavareh, D. et al 2015 Kinetic energy management in road traffic injury prevention: a call for action. *Journal of Injury Violence Research*, 7(1): 36-37.

³ Haddon, W. 1972 A logical framework for categorizing highway safety phenomena and activity, *Journal of Trauma*, 12:193--207.

⁴ Haddon, W. 1973 Energy damage and the 10 countermeasure strategies, *Journal of Trauma*, 13: 321-331.

⁵ Sleet, D. et al 2011 Injury Prevention, Violence Prevention, and Trauma Care: Building the Scientific Base, *CDC Supplements*, October 7, 60(04):78-85.

⁶ <http://content.tfl.gov.uk/safe-streets-for-london.pdf> accessed 4th January 2015.