
Effectiveness of road safety interventions: an evidence and gap map

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Title of the EGM

Effectiveness of road safety interventions: an evidence and gap map

Background

Motorized road transport poses substantial risks to human health unless steps are taken to actively manage safety. Road traffic injuries (RTI) have emerged as a leading cause of health loss in all countries around the world (WHO 2018). In low and middle-income countries, traffic injuries have been steadily rising, and now rank in the top ten causes of death (WHO 2018). Over fifty percent of the victims are pedestrians, bicyclists, and motorcyclists and RTI has become the leading cause of death for young adults in most countries. While most high-income countries (HIC) have well established road safety policies, many LMICs are in the process of establishing national regulatory agencies and sustainable funding streams to support large scale interventions that systematically address risky behaviours and the safety characteristics of vehicle and road infrastructure.

The Decade of Action for Road Safety 2011–2020, officially proclaimed by the UN General Assembly in March 2010, seeks to save millions of lives by building road safety management capacity; improving the safety of road infrastructure; further developing the safety of vehicles; enhancing the behaviour of road users; and improving post-crash response.¹ Several national and international initiatives have been taken over the past decade to promote and fund road safety initiatives around the world. While there is reasonable agreement internationally on safer designs of motor vehicles (except locally produced vehicles like three-wheeled scooter taxis, tuk-tuks, jeepneys, etc.), there is a lack of evidence based interventions in road and infrastructure design, police enforcement and post-crash care (Davey and Freeman 2011, Wilson and Gangathimmaiah 2017, Ezra 2019).

LMICs are also growing their rural road and highway infrastructure. National governments and international development agencies consider the expansion of road infrastructure a key strategy for economic and social development. In the last two decades, China has built a highway system that rivals that of the US, with plans of substantial expansion (Yan 2011, Xu and Nakajima 2015). In India, rapid growth of the highway infrastructure is currently underway because insufficient road transport is viewed as a key impediment to industrial growth (Ghani and Goswami 2013). Africa, where most people do not have access to all-

¹ https://www.who.int/roadsafety/decade_of_action/en/

weather roads, plans to expand its road network by six to ten times by 2040 (Programme for Infrastructure Development in Africa 2013).

Unfortunately, in the absence of local research on road-related safety interventions, roads and highways in LMICs are being designed to safety standards of high-income countries without an adequate understanding of the evidence base of existing standards. For example, it is generally accepted that traffic calming measures like chicanes, road narrowing and roundabouts are effective in reducing RTI (Bunn *et al.* 2003). However, effectiveness of some of these measures in LMICs is not known as vehicles like motorised two-wheelers may not be affected. Even in high income countries, many standards for vehicles, roads and policing activities are being promoted without the availability of adequate scientific evidence regarding their effectiveness (Elvik 2017, Ezra 2019). Many systematic reviews also point out the fact that evidence for road safety interventions may be available for HICs, but the same is lacking from LMICs (Roberts *et al.* 2003, Mulvaney *et al.* 2015).

A mapping will provide a comprehensive overview of existing knowledge in the area of road safety and its effectiveness across the world. The map will guide programme managers to high quality evidence and inform targeted commissioning of future research (Snilstveit, Vojtkova, Bhavsar, Stevenson, & Gaarder, 2016).

Existing EGMs

A map of evidence maps conducted in low- and middle-income countries identified no EGM conducted around transportation and other adaptive measures (Phillips, 2017).

The following systematic reviews have been identified:

Cochrane Reviews

Beyer FR, Ker K. (2009). Street lighting for preventing road traffic injuries. Cochrane Database of Systematic Reviews, Issue 1. Art. No.: CD004728.DOI: 10.1002/14651858.CD004728.pub2.

Wilson C, Willis C, Hendrikz JK, Le Brocque R, Bellamy N. (2010). Speed cameras for the prevention of road traffic injuries and deaths. Cochrane Database of Systematic Reviews, Issue 11. Art. No.: CD004607.DOI: 10.1002/14651858.CD004607.pub4.

Desapriya E, Harjee R, Brubacher J, Chan H, Hewapathirane DS, Subzwari S, Pike I. (2014). Vision screening of older drivers for preventing road traffic injuries and fatalities.

Cochrane Database of Systematic Reviews 2014, Issue 2. Art. No.: CD006252. DOI: 10.1002/14651858.CD006252.pub4.

Bunn F, Collier T, Frost C, Ker K, Steinbach R, Roberts I, Wentz R. (2003). Area-wide traffic calming for preventing traffic related injuries. Cochrane Database of Systematic Reviews, Issue 1. Art. No.: CD003110. DOI: 10.1002/14651858.CD003110

Martin AJ, Marottoli R, O'Neill D. (2013). Driving assessment for maintaining mobility and safety in drivers with dementia. Cochrane Database of Systematic Reviews, Issue 8. Art. No.: CD006222. DOI: 10.1002/14651858.CD006222.pub4.

Duperrex O, Roberts I, Bunn F. (2002). Safety education of pedestrians for injury prevention. Cochrane Database of Systematic Reviews, Issue 2. Art. No.: CD001531. DOI: 10.1002/14651858.CD001531.

Kwan I, Mapstone J. (2006). Interventions for increasing pedestrian and cyclist visibility for the prevention of death and injuries. Cochrane Database of Systematic Reviews, Issue 4. Art. No.: CD003438. DOI: 10.1002/14651858.CD003438.pub2

Mulvaney CA, Smith S, Watson MC, Parkin J, Coupland C, Miller P, Kendrick D, McClintock H. (2015). Cycling infrastructure for reducing cycling injuries in cyclists. Cochrane Database of Systematic Reviews, Issue 12. Art. No.: CD010415. DOI: 10.1002/14651858.CD010415.pub2.

Liu BC, Ivers R, Norton R, Boufous S, Blows S, Lo SK. (2008). Helmets for preventing injury in motorcycle riders. Cochrane Database of Systematic Reviews, Issue 1. Art. No.: CD004333. DOI: 10.1002/14651858.CD004333.pub3.

Galvagno Jr SM, Sikorski R, Hirshon JM, Floccare D, Stephens C, Beecher D, Thomas S. (2015). Helicopter emergency medical services for adults with major trauma. Cochrane Database of Systematic Reviews, Issue 12. Art. No.: CD009228. DOI: 10.1002/14651858.CD009228.pub3.

Macpherson A, Spinks A. (2008). Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. Cochrane Database of Systematic Reviews, Issue 3. Art. No.: CD005401. DOI: 10.1002/14651858.CD005401.pub3

Non-Cochrane reviews

Huemer, AK., Schumacher, M., Mennecke M., & Vollrath, M. (2018). Systematic review of observational studies on secondary task engagement while driving. *Accident Analysis & Prevention*, Vol 119, 225-236

- Roshandel, S., Zheng, Z., & Washington, S. (2015). Impact of real-time traffic characteristics on freeway crash occurrence: Systematic review and meta-analysis. *Accident Analysis & Prevention*, Vol 79, 198-211
- Brieger, F., Hagen, R., Vetter, D., Dormann, C.F., & Storch, I. (2016). Effectiveness of light-reflecting devices: A systematic reanalysis of animal-vehicle collision data. *Accident & Prevention*, Vol 97, 242-260
- Theofilatos, A., & Yannis, G. (2014). A review of the effect of traffic and weather characteristics on road safety. *Accident Analysis & Prevention*, Vol 72, 244-256
- Unsworth, C.A., & Baker, A. (2014). Driver rehabilitation: A systematic review of the types and effectiveness of interventions used by occupational therapists to improve on-road fitness-to-drive. *Accident Analysis & Prevention*, Vol 71, 106-114
- Elvik, R., & Greibe, P. (2005). Road safety effects of porous asphalt: A systematic review of evaluation studies. *Accident Analysis & Prevention*, Vol 37, 515-522
- Decker, J.S., Stannard, S. J., McManus, B., Wittig, S.M.O., Sisiopiku, V. P., & Stavrinou, D. (2015). The impact of billboards on driver visual behaviour: A systematic literature review. *Traffic Injury Prevention*, Vol 16, Issue 3
- Fu, C., Zhang, Y., Qi, W., & Cheng, S. (2016). Effects of digital countdown timer on intersection safety & efficiency: A systematic review. *Traffic Injury Prevention*, Vol 17, Issue 1
- Desapriya, E. Subzwari, S., Sasges, D., Basic, A., Alidina, A., Turcotte, K., & Pike, I. (2010). Do light truck vehicles (LTV) impose greater risk of pedestrian injury than passenger cars? A meta-analysis and systematic review. *Traffic Injury Prevention*, Vol 11, Issue 1
- Kim, Chang-Yeon., Wiznia.D.H., Averbukh, L., Dai, F., & Leslie, M.P. (2015). The economic impact of helmet use on motorcycle accidents: A systematic review and meta-analysis of the literature from the past 20 years. *Traffic Injury Prevention*, Vol 16, Issue 7
- Napolitano LM, Prehospital tranexamic acid: what is the current evidence? *Trauma Surgery & Acute Care Open* 2017;2:e000056. doi: 10.1136/tsaco-2016-000056

Synthesis of studies

The SafetyCube project synthesized existing knowledge on road safety risk factors and countermeasures in comprehensive synopses. These are listed as per risk factor / measure, colour code (assigned to reflect the strength of evidence on the effect of the risk factor or measure), and the road safety area concerned (behaviour, infrastructure, vehicle) at <https://www.roadsafety-dss.eu/#/knowledge>

Suggested dimensions

The EGM will have two primary dimensions: interventions (rows) and outcomes (columns). Additional dimensions will be:

- Geography (Low income, medium income, high income as per World Bank classification)
- Systematic review quality (low, moderate, high)
- Type of primary study (RCT, non-RCT, Observational study)
- Status of study (completed, ongoing)

In the hard copy of the EGM, multiple 2x2 representations of the EGM will be reported. A copy of the coding form will be included as an annex to the protocol and the main EGM report as per Campbell Collaboration guidelines for EGMs.

In the online version, selected additional dimensions will be possible to use as a filter. The online version will include references to included studies and brief summaries of each study (for impact evaluation studies) or plain language summary (for systematic reviews) provided for it.

Intervention(s) or problem

In order to define the scope of the review, the author team reviewed various policy documents, and conducted internal discussions.

The EGM will include any intervention aiming to reduce road traffic injuries and fatalities as an objective

Table 1 shows the detailed set of intervention categories. These may be modified during the piloting stage.

Table 1: Intervention categories and Examples

Category	Examples
Road user risk factors and behaviour	Enforcement: Manual enforcement by police officers and automated devices like red light and speed cameras. Public education and information Driver/rider training Penalties
Vehicle design and protective devices	Motorcycles, non-motorised vehicles and intermediate public transport vehicles

Road and infrastructure design	Road geometry (lane widths, horizontal and vertical curves, segregate lanes for bicycle, motorcycle, Roundabouts, Median, Shoulder, Pavement design, traffic calming Road furniture Traffic control (Road markings and signs, one-way rounds, vehicle restrictions, ITS, pedestrian facilities, speed limits)
Pre-hospital care	Bystander and driver training (first-aid) Ambulance design and equipment Ambulance personnel training Stay & Play vs Scoop and Run Time to hospital Helicopter use
Legal and institutional framework	Insurance Fiscal measures (vehicle and fuel taxes, road/bridge pricing) Agencies (Central Road Safety Agency, National Road Safety Council, Safety departments in road building agencies, Research centres; stand-alone and in educational institutions)
Non-intervention categories	Changes in modal share Volume (safety in numbers)

Population

This being a global EGM, it will include populations living in all continents.

The online map will contain filters so that just the evidence satisfying that criterion is shown (see Table 2).

Table 2: Additional filters

	Human	Vehicle	Environment
Pre-event	Public campaigns/awareness education	Visibility/visual aids/brakes, daytime running lights.	Road safety feature/design
Event	Helmet use, belt use	Laminated wind shields, air bags, vehicle crashworthiness	Crash protective road side safety objects
Post-event	Emergency care, Rehabilitate and improve healthcare services	Non-exploding fuel tanks	Facilities for early rescue

Outcomes

The outcomes are listed in outcome domains ordered along the causal chain (Table 3). Each domain has a number of sub-domains. These may be modified during the piloting stage.

Table 3 EGM Outcomes

Domain	Sub-domain
Health and accidents	1. Reduction in fatalities 2. Reduction in non-fatal injury crashes
Safe road-use practices	1. Wearing seat belts/ helmets 2. Impaired driving (under influence, with medical condition)

Study designs

The EGM will include randomised controlled trials (RCTs), non-randomised controlled trials, and observational studies, along with systematic reviews on road safety interventions effectiveness. Included empirical studies (i.e. exclude all theoretical, modeling, or laboratory studies) must be based on quantitative evaluations using experimental, quasi-experimental or observational design that attribute change in outcome to a specific intervention.

Stakeholder engagement

The framework to be presented at the protocol stage will be further developed through the following process:

Stage 1: Initial framework to be constructed through review of strategy and policy documents, and discussions through external consultations through, (i) An Advisory Group specially nominated for this project and (ii) Discussion with ICoRSI Council Members

Stage 2: Piloting framework with 30 included studies. The framework will be finalized once the first 30 studies are coded. The protocol will be revised at this point.

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Roles and responsibilities

- ***Content expertise:***

Dinesh Mohan, Geetam Tiwari, Kavi Bhalla, and Mathew Varghese are members of ICoRSI and have been working on transport research and road safety interventions for many years. These authors will be providing the content expertise for the EGM.

- ***Systematic review method expertise:***

Howard White, Denny John and Ashrita Saran, are experienced systematic reviewers which means that they are proficient in conducting various processes in an EGM, such as screening, quality assessment and coding.

Denny John will manage the process of screening, coding and quality assessing primary studies and systematic reviews. He has more than 6 years of experience as a systematic review author, as well as formal training.

Dinesh Mohan, Geetam Tiwari, Kavi Bhalla, and Mathew Varghese were trained by Campbell staff (Howard White, Denny John, Ashrita Saran) on systematic review and EGM methods in a workshop conducted at IIT-Delhi in December 2018.

- ***EGM methods expertise:***

Howard White as CEO provides technical and strategic support for the development of EGM in Campbell library. Previously, he has initiated and led the development of EGM during his association with 3ie. Denny John is currently co-author of 2 ongoing EGM registered with Campbell library. Along with Howard White, Ashrita Saran is leading many EGMs in Campbell Library.

- ***Information retrieval expertise:***

Denny John, and Ashrita Saran, in consultation with Howard White, and other authors will provide information retrieval expertise for the EGM.

Funding

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Potential conflicts of interest

No conflicts of interest

Preliminary timeframe

Protocol submission: June 2019

EGM submission: November 2019