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Independent Council for
Road Safety International

ICORSI'S COMMENTS ON WHO'S DRAFT GLOBAL TARGETS FOR ROAD SAFETY RISK FACTORS

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Summary: A recent United Nations General Assembly resolution has asked the World Health Organization (WHO) to develop voluntary global performance targets on key road safety risk factors. These targets will be used to track how well countries are doing in reducing deaths and injuries from traffic crashes. WHO has produced a draft set of country-level targets and invited feedback from state and non-state actors. This document provides feedback from ICoRSI about the targets proposed by WHO.

About ICoRSI: The Independent Council for Road Safety International (ICORSI) is a not-for profit organization that provides independent and authoritative advice on global road safety policies by road safety scientists that have no financial conflicts of interest. ICoRSI aims to: (1) provide rapid, independent and evidence-based information on road safety policy and practice to policy makers and the public; (2) strengthen the capacity of safety professionals and policy makers to understand existing evidence and undertake new research; and, (3) facilitate capacity building for safety professionals and policy makers in the field of transportation safety.

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INTRODUCTION

Reliable statistics on the incidence of traffic injuries and key risk factors are important for developing road safety programs. While deaths are either rising or are stable at a high level in low- and middle-income countries (LMICs), many OECD countries have had remarkable success in improving traffic safety over the last five decades (OECD/ITF 2016). Targets backed by a package of evidence-based interventions were an important part of their success. Other nations should be encouraged to adopt a similar process of continuous improvement and learning. Setting targets and tracking their associated indicators can help national agencies coordinate their efforts. They make it possible for researchers to do cross-country comparisons and to learn from the experience of others. Importantly, targets allow citizens to see deficits in their countries and demand corrective action from local authorities.

The World Health Organization (WHO) has developed a draft set of voluntary global targets for road safety risk factors and distributed a Discussion Paper *Draft: Developing voluntary global targets for road safety risk factors and service delivery mechanisms (henceforth referred to as "WHO's Draft Discussion Paper"*) for public comment. For WHO's proposed targets and indicators to be effective in helping to improve road safety, it is important that they are reasonably comprehensive (i.e. the targeted risks account for a large proportion of the problem), comparable (i.e. have consistent definitions across countries), and reasonably accurate. With these principles in mind, we make the following recommendations about the draft global targets for road safety risk factors that have been proposed by WHO.

DATA COLLECTION AND ANALYSIS

VALIDITY OF DATA COLLECTION PROCEDURES

In the previous WHO Global Status Reports on Road Safety (GSRRS), data on country indicators were based on a consensus of local road safety experts (WHO 2015). Although the process of data collection of the new data on risk factors is unclear, it appears that these will be collected by WHO using a procedure similar to those used in previous GSRRS reports. However, in settings where there are no empirical measurements of risk factors, consensus among a local committee of experts will often not result in meaningful statistics. For instance, in the 2009 GSRRS, Afghanistan reported a perfect score of 10 (on a 0-10 scale) for speed enforcement,

substantially ahead of France, which reported a score of 7 (WHO, 2009). These issues continue to plague subsequent GSRRS reports. For instance, in the 2015 GSRRS, countries that scored a perfect 10 on seatbelt enforcement included Kazakhstan, Gambia, Turkmenistan and UAE, ahead of Sweden which scored only 8, even though Sweden is known to have nearly 100% seatbelt use (WHO, 2015). The 2015 GSRRS reported that pedestrians constituted 9.1% of traffic fatalities in India, even though research reports indicate that this number may be excess of 30% (Hsiao *et al.* 2013, Mohan *et al.* 2015, Bhalla *et al.* 2016). Despite these obvious problems, once WHO has published these data, many researchers assume that the data are meaningful. There are many examples already of published studies that have used these data in cross-country comparative analysis.

WHO's Draft Discussion Paper encourages "All countries to address long term goals" such as "zero deaths and injuries on the road" but does not emphasize the need for reliable and objective measures to assess progress in achieving such goals. While counting deaths and injuries from highway crashes may seem straightforward, it is not. Even though counting all crash fatalities can be a relatively straightforward task, having related information on fatally injured persons (car occupants, motorcycle riders, pedestrians, etc.) adds significant complexities to this task. Furthermore, also collecting reliable information on the types of fatal crashes (single- or two-passenger vehicles, car/motor cycle, car/bus/truck pedestrian, etc.) is even more complicated. When establishing policies, basic road traffic injury (RTI) analysis requires that at a minimum we have available the ages of victims and drivers, cross-tabulations for victims (road user type) vs struck vehicle or object, place of crash, alcohol involvement and time of crash. Very few countries do this well. The collection of non-fatal injury, even serious injuries, is even more challenging.

TARGETS

Recognizing the shortage of objective measures of progress WHO proposes sets of intermediate indicators. Some of these are also overly prescriptive and in many instances, will be unlikely to improve safety and, in some instances, could lead to increases in deaths and injuries. Target setting must include outcome indicators (deaths/injuries) for different users. Targets should also be road user specific giving priority to vulnerable road users. Countries also need to explain the mechanism they propose for achieving the targets. Just setting a target is not enough. For example, if a country says that they will reduce motorcyclist deaths by X%, they have to indicate how much reduction they expect to achieve by each measure - helmets, daytime lights, alcohol control, ABS and combined braking, etc. Then, for each measure, by when will the legislation be introduced, how much will be spent on communication with the public, how much investment in new technologies and personnel for enforcing each item, and systems set up for evaluating the outcome.

In the vehicle section on page 7 of the WHO Draft Discussion Paper, it is proposed that countries set a target for adopting UN regulation R94 for frontal impact protection. Most current cars (except the low speed small vehicles) can probably meet the UN front and lateral crashworthiness standards without significant design changes. The danger with these kinds of weak intermediate targets is that they allow governments and, in this example, vehicle

manufacturers, to declare victory without making much progress. UN regulations are lagging behind the best available international testing procedures and standards. The variousNCAPs and other consumer testing programs have driven vehicle safety improvements much faster than UN regulations ever could. In Europe and North America these testing programs have become de facto standards for the manufacturers, and the actual government vehicle safety regulations have become little more than the basic minimum specifications that every new car must meet. This should not be surprising since, by definition, government rulemaking is a slow process, whereas consumer information, especially comparisons that highlight significant safety differences among otherwise comparable models, can and have produced rapid safety improvement. Plus, automobile suppliers in particular are rapidly advancing the state-of-the art in vehicle safety with advanced technologies such as Automatic Emergency Braking (AEB) including speed control, and formal rulemaking cannot keep up with the current pace of vehicle safety innovation.

In the road section on page 8 of the WHO Draft Discussion Paper, it is recommended that member countries set a target for a certain percentage of new roads that are 3 star (iRAP) or better for all road users. This is too prescriptive as evidence of the reliability of these ratings is not available for range of modal shares and traffic volumes for all locations in the world. In the absence of reliable RTI data in many locations at present it is even difficult to validate the reliability of iRAP ratings. The document also states “Cost-effective infrastructure solutions exist for all crash types”. This statement is not true as evidence based design guidelines for urban arterials and highways with high proportion of non-motorized and other slow traffic are still not available.

It would be advisable to leave room for new evidence and developments. Setting of targets should be based on best evidence-based standards and procedures available for different needs and situations.

NEED FOR A TARGET THAT FOCUSES ON IMPROVING QUALITY OF INJURY STATISTICS

Arguably, the death toll is the most important indicator of road safety performance for a country. Quantitative targets aimed at reducing the death toll are a core part of the Safe System approach. Yet, official statistics in many low- and middle-income countries (LMICs) substantially underreport the road death toll. For instance, in the two most populous countries, China and India, the 2015 WHO Global Status Report on Road Safety (GSRRS) estimated traffic deaths that were 4.5 and 1.5 times official statistics in each country (WHO, 2015). Without reliable measurements of trends in the national death toll, LMICs will struggle to convince their citizens that their safety programs are working. In this sense, unreliable statistics of injuries are a risk factor for road safety.

We recommend that WHO include targets and a set of indicators that focus on improving the quality of traffic injury statistics in a country. Among these, targets and indicators that focus on under-reporting of deaths are likely the most important. Such an indicator could be constructed, for instance, by comparing country deaths estimated by WHO and other agencies, such as the Global Burden of Disease project, with official government statistics.

NEED FOR A TARGET THAT FOCUSES ON REDUCING VEHICLE MILES TRAVELED

Page 5 of WHO's Draft Discussion Paper notes that one of the criteria for identifying targets is that they help meet other health co-benefits. We assume that this is a reference to road safety targets that can simultaneously help reduce vehicular air pollution and/or help increase walking, bicycling, and other forms of physical activity. However, it is possible increases in walking, bicycle use and public transport can result in increases in RTI unless they are accompanied by safer infrastructure, reduction in speeds etc. (Bhalla *et al.* 2007, Woodcock *et al.* 2009, Stevenson *et al.* 2016). However, the WHO draft does not propose any targets that would ensure that greater use of non-motorized modes is accompanied with specific measures that ensure safety for such modes.

NEED FOR VEHICLE DESIGN INDICATORS THAT ARE REASONABLY COMPREHENSIVE

In the section on vehicle safety, the only indicators recommended by WHO are four UN regulations on vehicle safety. The first of these, UN regulation R94 on frontal impact protection for occupants, is extremely weak and far behind the state of the art. It is unlikely to result in any significant safety improvement for most vehicles and is inappropriate for the class of low speed vehicles, such as autorickshaws and tuktuks, that are commonly used in LMICs. This is also the case for the UN side impact protection rule mentioned in the justification (last column of Table 1 of WHO's Draft Discussion Paper). These two standards reflect the state-of-the art front and side impact protection from decades ago. In contrast, two other UN regulations mentioned in the document (electronic stability control, and combined motor cycle braking) reflect technologies, which if implemented, would significantly reduce the crashes of these vehicles. However, even though the effectiveness of ESC has been shown repeatedly by good research to be one of the most effective vehicle safety improvements introduced in high-income countries (Farmer 2010, Strandroth *et al.* 2012, Starnes 2014, Lyckegaard *et al.* 2015), it is also important that, where feasible, the effectiveness of new technologies be assessed in countries where vulnerable road users constitute a high proportion of road users.

Second, these indicators focus solely on government regulation and ignore mechanisms that provide consumers with information about the safety performance of vehicles. UN regulations are weak and their implementation provides only a minimal level of protection. In contrast, competition resulting from testing by New Car Assessment Programs (NCAPs) has led auto companies to implement additional safety features and designing to standards that far exceed UN regulations. As one example, rapid improvements in crash avoidance technologies (such as automatic emergency braking) are expected to have a large effect on safety (notably including non-occupants). Automatic Emergency Braking (AEB) and other crash avoidance technologies promise to produce significant reductions in deaths and injuries to vehicle occupants and vulnerable road users. Although these technologies are relatively expensive today, as they become more widely deployed their costs will drop dramatically. Since it will take some time and much expense to introduce effective policing measures to control speeds in most countries, these new technologies may in fact have the possibility of becoming quite cost effective in reducing RTI.

Given the rapidly developing new vehicle safety technologies, government regulations will fall further and further behind, but fortunately they are not the only ways to drive the implementation of these technologies. Therefore, WHO should consider including targets and indicators that also enable market mechanisms to encourage auto companies to include these features in new cars. Thus, while auto manufacturers in all markets should meet all UN safety regulations for new vehicles to establish basic minimum levels of safety, they should also be incentivized through consumer and market place information to go beyond these minimums.

A major problem is the perception, even among many safety professionals, that state of the art safety is expensive. In many cases this is not so. Suppliers sell driver side airbag modules for as little as $20. Therefore, even accounting for sensors a frontal airbag system likely costs manufacturers less than $100. Side impact curtain airbags should have a similar cost. Why is there the perception that safety technology is expensive? In part this is because around the world manufacturers are bundling safety features with luxury items such as leather seats, expensive stereo systems and chrome (Mohan and Jha 2015)! This needs to change. WHO and individual governments should be pushing for the separation of safety and luxury in car marketing.

Third, it is important to carefully consider and prescribe what vehicles are covered by government regulations. Thus, for example, it is important that crashworthiness standards that focus on pedestrian safety, also cover buses and trucks. So far vehicle design regulations for pedestrian safety have often only been applied to passenger cars. However, in many LMICs, buses and trucks kill far more pedestrians than cars (Mohan *et al.* 2015, Bhalla *et al.* 2016, Mohan *et al.* 2016).

There are also various kinds of underpowered vehicles (e.g. auto rickshaws, and tuk-tuks, among others) that may have low injury rates partly because of their low operating speeds (Mohan and Bhalla 2016). Current vehicle crashworthiness standards are not suitable for these low velocity vehicles used in urban settings. These vehicles should not be subject to existing crashworthiness regulations. There should be a target for developing new standards for these vehicles, which play an important role in many countries.

Finally, only targeting new vehicles is not sufficient. New vehicle standards effect change over a long period because auto companies need to be given a lead-time for introducing new models, and it takes many years of sales of the new models and attrition of old models before the vehicle fleet primarily consists of safer cars. Therefore, it is important that targets and indicators be included that encourage countries to deploy a wide range of technologies on existing vehicles. For example, these include:

- Daytime running lights (DLR). These are especially important for improving visibility of motorized two wheelers and may have a significant effect in lowering fatality rates that have a significant proportion of these vehicles in their fleet (Robertson 1976, Zador 1985, Yuan 2000, Radin Umar 2006, Davoodi and Hossayni 2015). DRL for motorcycles will have a similar positive effect as DRL for cars; it improves contrast effects and changes of contrast and thereby increases awareness and alertness by other road users.

- Side guards in heavy vehicles. These devices are effective at keeping pedestrians, bicyclists, and motorcyclists from being run over by the rear wheels of vehicles, which is a common type of crash in many LMICs.
- Alcohol Interlocks. These devices which require a driver to blow into a breathalyzer before starting the vehicle have already been deployed by countries, cities and companies in commercial vehicle fleets, public transport vehicles, and among previous drink driving offenders. New technology that would stop drivers from operating a vehicle if drunk may be in commercialized in the near future (Zaouk *et al.* 2015).

Targets should push governments to invest in the development of these technologies and adopt them as soon as they are available. Doing so may be more economical in the long run than programs based on policing enforcement.

NEED FOR INFRASTRUCTURE INDICATORS THAT ARE EVIDENCE-BASED

It is essential, as the WHO Draft Discussion Paper acknowledges, that the chosen targets and indicators are based on evidence that they improve road safety. The proposed target for design of infrastructure relies solely on star-ratings by the International Road Assessment Program (IRAP). However, there is insufficient evidence that following IRAP recommendations always leads to safer roads in countries with a high proportion of vulnerable road users

At present, there are only a small number of studies that have evaluated the effect of improving road star-ratings and real-world crash risk. Furthermore, these studies are from high-income countries, with little evidence available from LMICs. While it is true that some of the infrastructure measures proposed by IRAP to improve star ratings are likely to reduce injury risks (e.g. inclusions of sidewalks and median barriers), it is also common for IRAP to recommend other measures (e.g. lane widening and road surface upgrades) that can cause an increase in vehicle speeds. In settings with a large number of pedestrians, bicyclists, and motorcyclists, increases in speed will usually lead to more injuries. Therefore, we recommend that IRAP star-ratings should not be used for global targets and indicators until there is sufficient evidence that roads in LMICs built to IRAP recommendations are actually safer.

Instead, we recommend that WHO include indicators that provide direct measures of the availability of infrastructure that are known to be important for safety. And, WHO should include targets that encourage LMICs to invest in developing the evidence on safety of infrastructure and develop star ratings. Improving roads in ways that facilitate faster travel speeds can result in increased mileage as well as higher risks for vehicle occupants. Also, some efforts to separate pedestrians, etc. from fast moving vehicles with overpasses etc. often fail (Baker 1977, Tiwari *et al.* 2007, Khatoon *et al.* 2013, Rankavat and Tiwari 2016). Many countries have developed comprehensive Traffic Calming strategies with significant improvements of safety for all types of road users (Bunn *et al.* 2003). However, the context in low and middle-income countries may be different e.g. with many more motorized two-and three wheelers as well as many more vulnerable road users. Experience from these countries is limited and there is a need for systematic trials in these countries in order to set reliable targets.

ROAD USER BEHAVIOR: NEED TO THINK BEYOND TRADITIONAL ENFORCEMENT

Controlling speeds through traditional enforcement systems has not been very effective. However, other measures, such as road design changes and concepts like camera enforcement do work (Dumbaugh and Li 2010, Wilson *et al.* 2010, Wood *et al.* 2015, Doi *et al.* 2016). Enforcement of laws against alcohol impaired driving require huge enforcement resources that are unlikely deployed in many jurisdictions. It would be more useful to include targets for introducing new technologies that provide safety automatically and infrastructure designs to influence behavior change.

NEED FOR MEANINGFUL INFORMATION ON CAPACITY OF GOVERNMENT INSTITUTIONS AND RESEARCH INSTITUTIONS TO MANAGE ROAD SAFETY

Much of the advancement in reducing RTI and fatality has come from development of new theories and understanding about what works and does not work (Haddon 1980, Elvik 2004, Johnston 2010). This needs research institutions and experts to work on the more complex problems of the day and provide guidance to policy makers in the absence of which many wrong designs and standards get adopted (Hauer 2005). In many regions there is a great shortage of trained manpower at all levels, research and practice (National Transport Development Policy Committee 2014). Therefore, it is very important that indicators be evolved and targets set related with measuring how many road safety professionals there are in each country or region with training and experience in road safety.

The WHO Draft Discussion Paper notes that the indicators for institutional capacity would be the same as those used in the 2015 WHO Global Status Report. However, the data on institutional capacity provided in that report have proven to be difficult to interpret. For instance, 167 countries reported having a national agency, and 131 had road safety strategies that were funded. These included countries like Afghanistan, Chad, Democratic Republic of Congo, India and Central Republic of Africa, and many others that are known to have weak institutions and poor governance. Therefore, WHO's existing methods of collecting data on institutional functions are not working well. We recommend that countries should be asked to provide specific information about indicators of institutional capacity rather than yes/no questions. For instance, the indicator on "Funding Stream" should specify the source and amount of resources (e.g. x% gasoline tax). More generally, we recommend WHO develop more objective measures of institutional capacity by using, for instance, the 2013 World Bank Guidelines for Road Safety Management Capacity Reviews, which provides a series of checklists.

NEED FOR INDICATORS ON TRAUMA MANAGEMENT

The medical care of injured patients has three components: (1) pre-hospital care and transport; (2) definitive care at a hospital facility and (3) rehabilitation. The WHO draft target only provides reduction in time to first contact as an indicator for pre-hospital care. Countries must aim to provide at least the essential components of care/resources listed in WHO guidelines (Mock *et al.* 2004, Sasser *et al.* 2005) and provide timelines for achieving these targets. However, many

LMICs have severe deficiencies in their ability to provide hospital care and effective rehabilitation due to resource limitations. It is arguable that addressing these deficiencies is at least as important as addressing pre-hospital care. Notably, WHO has previously published two reports that provide guidance on how to assess the ability of countries to provide trauma care (Mock *et al.* 2004, Sasser *et al.* 2005).

New research studies suggest that some of the trauma care procedures, hospital and pre-hospital, prevalent in most countries are not based on latest scientific evidence (Kwan *et al.* 2004a, b, Sanghavi *et al.* 2015). In recent years, large international clinical trials have identified some highly cost-effective treatments for bleeding trauma patients. In particular, tranexamic acid has been found to reduce mortality in extracranial bleeding (CRASH-2 trial collaborators 2010, CRASH-2 collaborators 2011, Guerriero *et al.* 2011).

We recommend that existing WHO guidelines and the best available scientific literature should be used to develop indicators that cover the entire spectrum of care that is needed for traffic crash victims and include mechanisms to judge whether the most effective procedures and treatments have been put into practice.

FINAL WORD OF CAUTION

When targets and indicators are successfully implemented, they can be a powerful force for organizing action and shaping public dialog. However, this success comes at a price. Issues that are covered by the target become the primary focus of public policy while issues that are not covered by the indicator can get neglected. At present, the draft targets that have been proposed by WHO carry the danger that important areas for road safety will get very narrowly or incorrectly framed based on the interests and expertise of key stakeholders that have helped develop these targets. In particular, it is important that the important area of vehicle safety is not reduced to compliance with crashworthiness standards, especially standards that are out of date. And, that infrastructure safety is not reduced to IRAP star-ratings until there is adequate evidence of effectiveness. Instead, it is critical that these targets reflect the comprehensive view of road safety that was at the core of WHO's 2004 World Report on Road Traffic Injury Prevention.

A fundamental principle that WHO should adopt is that every intermediate target and indicator (i.e. ones that are not based on counts of deaths and injuries) it recommends must be justified by evidence based research on its field effectiveness, and the WHO report must document, with appropriate references, etc., this research. Furthermore, as countries sign on to this program by adopting some or all of the recommended programs, they must also indicate the resources that will be available to ensure that each program adopted has a realistic chance to be successful. Thus, for example, passing laws addressing road user behavior without also providing resources for enforcement should not be a sufficient response.

Finally, a major factor limiting road safety progress in many countries is the lack of road safety professionals, and as a result the issue is often captured by well-meaning politicians and amateurs who often support programs (e.g. severe punishments, advanced driver training, etc.) that do not work and sometimes actually increase the risks. Even having a cadre of road safety

professionals in a country (in government, universities, and other research organizations) does not guarantee that ineffective programs will not be adopted, this can happen because most road users believe they know what will work. When knowledgeable professionals are involved in the process, however, there is a much greater chance that evidence based programs will be adopted, and the WHO report needs to emphasize the importance of this key need.

REFERENCES

Baker, S.P., 1977. Pedestrian deaths in rio de janeiro and baltimore. Accident Analysis & Prevention 9 (2), 113-118.

Bhalla, K., Ezzati, M., Mahal, A., Salomon, J., Reich, M., 2007. A risk-based method for modeling traffic fatalities. Risk Analysis 27 (1), 125-136.

Bhalla, K., Khurana, N., Bose, D., Navaratne, K.V., Tiwari, G., Mohan, D., 2016. Official government statistics of road traffic deaths in india under-represent pedestrians and motorised two wheeler riders. Injury Prevention.

Bunn, F., Collier, T., Frost, C., Ker, K., Roberts, I., Wentz, R., 2003. Traffic calming for the prevention of road traffic injuries: Systematic review and meta-analysis. Injury Prevention 9 (3), 200-204.

CRASH-2 Collaborators, 2011. The importance of early treatment with tranexamic acid in bleeding trauma patients: An exploratory analysis of the CRASH-2 randomised controlled trial. Lancet 377 (9771), 1096-101, 1101.e1-2.

CRASH-2 Trial Collaborators, 2010. Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): A randomised, placebo-controlled trial. Lancet 376 (9734), 23-32.

Davoodi, S.R., Hossayni, S.M., 2015. Role of motorcycle running lights in reducing motorcycle crashes during daytime; a review of the current literature. Bulletin of Emergency And Trauma 3 (3), 73-78.

Doi, K., Sunagawa, T., Inoi, H., Yoh, K., 2016. Transitioning to safer streets through an integrated and inclusive design. IATSS Research 39 (2), 87-94.

Dumbaugh, E., Li, W., 2010. Designing for the safety of pedestrians, cyclists, and motorists in urban environments. Journal of the American Planning Association 77 (1), 69-88.

Elvik, R., 2004. To what extent can theory account for the findings of road safety evaluation studies? Accident Analysis & Prevention 36 (5), 841-849.

Farmer, C.M., 2010. Effects of electronic stability control on fatal crash risk. Insurance Institute for Highway Safety, Arlington VA, pp. 1-18.

Guerriero, C., Cairns, J., Perel, P., Shakur, H., Roberts, I., 2011. Cost-effectiveness analysis of administering tranexamic acid to bleeding trauma patients using evidence from the CRASH-2 trial. PLoS One 6 (5), e18987.

Haddon, W., Jr., 1980. Options for the prevention of motor vehicle crash injury. Isr J Med Sci 16 (1), 45-65.

Hauer, E., 2005. The road ahead. Journal of Transportation Engineering 131 (5), 333-339.

Hsiao, M., Malhotra, A., Thakur, J., Sheth, J.K., Nathens, A.B., Dhingra, N., Jha, P., Collaborators, M.D.S., 2013. Road traffic injury mortality and its mechanisms in india: Nationally representative mortality survey of 1.1 million homes. BMJ open 3 (8), e002621.

Johnston, I., 2010. Beyond "best practice" road safety thinking and systems management - a case for culture change research. Safety Science 48 (9), 1175-1181.

Khatoon, M., Tiwari, G., Chatterjee, N., 2013. Impact of grade separator on pedestrian risk taking behavior. Accident Analysis & Prevention 50 (0), 861-870.

Kwan, I., Bunn, F., Roberts, I., 2004a. Spinal immobilisation for trauma patients (cochrane review) on behalf of the WHO pre-hospital trauma care steering committee. John Wiley & Sons, Ltd, Chichester, UK.

Kwan, I., Bunn, F., Roberts, I., 2004b. Timing and volume of fluid administration for patients with bleeding (cochrane review). On behalf of the WHO pre-hospital trauma care steering committee. John Wiley & Sons, Ltd., Chichester, UK.

Lyckegaard, A., Hels, T., Bernhoft, I.M., 2015. Effectiveness of electronic stability control on single-vehicle accidents. Traffic Injury Prevention 16 (4), 380-386.

Mock, C., Lormand, J.D., Goosen, J., Joshipura, M., Peden, M., 2004. Guidelines for essential trauma care World Health Organization, Geneva.

Mohan, D., Bhalla, K., 2016. Traffic safety: Emerging concerns for low and middle income countries. Journal of the Australian College of Road Safety 27 (2), 9-17.

Mohan, D., Jha, A., 2015. Automobile manufacturers, advertising and traffic safety in india. Economic & Political Weekly L (51), 28-30.

Mohan, D., Tiwari, G., Bhalla, K., 2015. Road safety in india: Status report. Transportation Research & Injury Prevention Programme, Indian Institute of Technology Delhi, New Delhi, pp. 1-93.

Mohan, D., Tiwari, G., Mukherjee, S., 2016. Urban traffic safety assessment: A case study of six indian cities. IATSS Research 39 (2), 95-101.

National Transport Development Policy Committee, 2014. Safety. India transport report: Moving india to 2032. Routledge, New Delhi, pp. 574-616.

OECD/ITF, 2016. Road safety annual report 2016. OECD/ITF, Paris, pp. 540.

Radin Umar, R., 2006. Motorcycle safety programmes in malaysia: How effective are they? International Journal of Injury Control and Safety Promotion 13 (2), 71-79.

Rankavat, S., Tiwari, G., 2016. Pedestrians perceptions for utilization of pedestrian facilities – delhi, india. Transportation Research Part F: Traffic Psychology and Behaviour 42, Part 3, 495-499.

Robertson, L.S., 1976. An instance of effective legal regulation: Motorcycle helmet and daytime headlamp laws. Law and Society (Spring), 467-477.

Sanghavi, P., Jena, A.B., Newhouse, J.P., Zaslavsky, A.M., 2015. Outcomes of basic versus advanced life support for out-of-hospital medical emergencies. Annals of Internal Medicine, 1-15.

Sasser, S., Varghese, M., Kellerman, A., Lormand, J.D., 2005. Prehospital trauma care systems World Health Organization, Geneva.

Starnes, M., 2014. Estimating lives saved by electronic stability control, 2008–2012. Research Note. National Highway Traffic Safety Administration, Washington, DC.

Stevenson, M., Thompson, J., De Sá, T.H., Ewing, R., Mohan, D., Mcclure, R., Roberts, I., Tiwari, G., Giles-Corti, B., Sun, X., Wallace, M., Woodcock, J., 2016. Land use, transport, and population health: Estimating the health benefits of compact cities. The Lancet. Elsevier.

Strandroth, J., Rizzi, M., Olai, M., Lie, A., Tingvall, C., 2012. The effects of studded tires on fatal crashes with passenger cars and the benefits of electronic stability control (esc) in swedish winter driving. Accident Analysis & Prevention 45, 50-60.

Tiwari, G., Bangdiwala, S., Saraswat, A., Gaurav, S., 2007. Survival analysis: Pedestrian risk exposure at signalized intersections. Transportation Research Part F: Traffic Psychology and Behaviour 10 (2), 77-89.

WHO, 2015. Global status report on road safety 2015. World Health Organization, Geneva, pp. 340.

Wilson, C., Willis, C., Hendrikz, J.K., Le Brocque, R., Bellamy, N., 2010. Speed cameras for the prevention of road traffic injuries and deaths. Cochrane Database of Systematic Reviews (11).

Wood, J.S., Gooch, J.P., Donnell, E.T., 2015. Estimating the safety effects of lane widths on urban streets in nebraska using the propensity scores-potential outcomes framework. Accident Analysis & Prevention 82, 180-191.

Woodcock, J., Edwards, P., Tonne, C., Armstrong, B.G., Ashiru, O., Banister, D., Beevers, S., Chalabi, Z., Chowdhury, Z., Cohen, A., Franco, O.H., Haines, A., Hickman, R., Lindsay, G., Mittal, I., Mohan, D., Tiwari, G., Woodward, A., Roberts, I., 2009. Public health benefits of strategies to reduce greenhouse-gas emissions: Urban land transport. Lancet 374 (9705), 1930-43.

Yuan, W., 2000. The effectiveness of the 'ride-bright' legislation for motorcycles in singapore. Accident Analysis & Prevention 32 (4), 559-563.

Zador, P.L., 1985. Motorcycle headlight-use laws and fatal motorcycle crashes in the us, 1975-83. American Journal of Public Health 75 (5), 543-546.

Zaouk, A., Willis, M., Traube, E., Strassburger, R., 2015. Driver alcohol detection system for safety (dadss) – a non-regulatory approach in the development and deployment of vehicle safety technology to reduce alcohol-impaired driving – a status update. 24th International Technical Conference on the Enhanced Safety of Vehicles (ESV). United States Department of Transportation, National Highway Traffic Safety Administration (NHTSA), Gothenburg, pp. 1-15.